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FEATURES
WINEMAKING SUPPLIES SHOWCASE

MAY/JUNE 2010

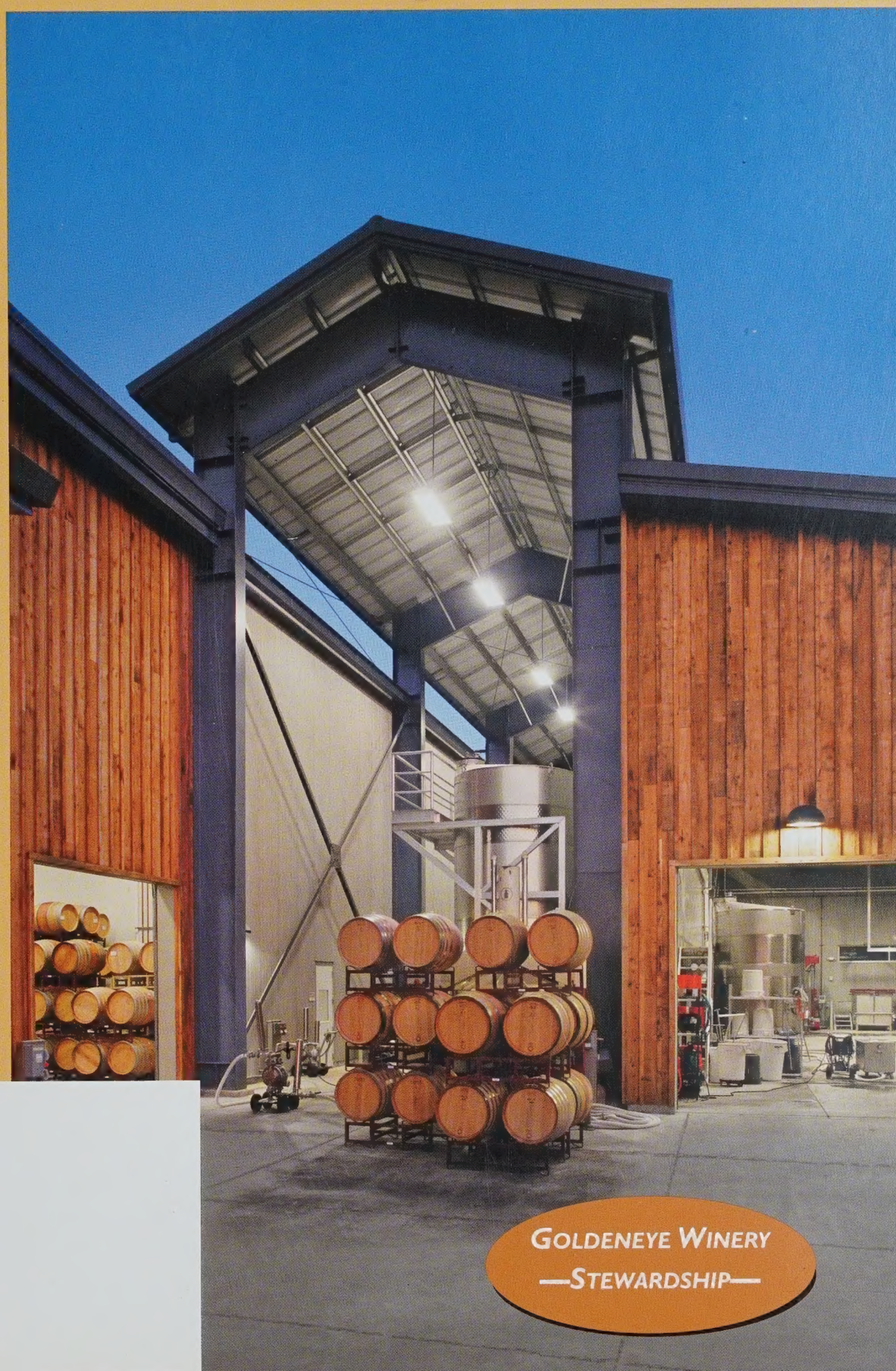
Determining optimal cluster exposure

Impact of fining on juice quality

Vine balance impact on methoxypyrazines

Maximizing aroma preservation

SMART VITICULTURE
Vine breeders



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Goldeneye Winery, Anderson Valley, CA. Photo by Michael Chambers.

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WINERY DESIGN

ANDERSON VALLEY PINOT NOIR

COMMITMENT TO STEWARDSHIP

BY Ron Verdier, Architect AIA, Boonville, CA

Goldeneye Winery's new production facility at Gowan Creek Vineyard, only 20 miles from the Mendocino Coast in the small town of Philo, CA, is the latest accomplishment for Duckhorn Wine Company. With an impressive portfolio of wineries, including Duckhorn Vineyards and Paraduxx in Napa Valley, and Goldeneye based in Anderson Valley, the new production facility addresses the Goldeneye brand's need for growth as its Anderson Valley Pinot Noir project comes of age.

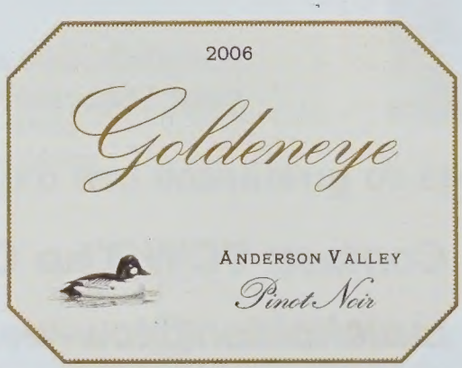
Goldeneye gets its name from a small Northern Hemisphere sea duck with black and white plumage and bright yellow irises. "We are a family of ducks," Dan Duckhorn once stated.

In 1996, Duckhorn Wine Company established itself in Anderson Valley and began developing its first estate vineyard for Goldeneye. Today there are 220 acres of Pinot Noir planted on five estate vineyards, with 19 clones on 11 different rootstocks. This provides Goldeneye Winemaker Zach Rasmuson with a rich and diverse palette of fruit with which to compose the wines. Goldeneye's Pinot Noir program was designed to create estate wines using small-lot artisan winemaking techniques.

In turn, this winemaking style helped shape the function of the new winery structures. Throughout their operations, the winery owners have made a commitment to environmentally-conscious stewardship of the land.

Goldeneye began in the Anderson Valley by establishing hospitality facilities in a beautiful old farmhouse on the Confluence estate, which they converted into a tasting room in the late 1990s. In a century-old redwood barn at Gowan Creek, another estate property four miles down the road, they made their first vintages. As the vines matured, and both the estate program and production increased, it was apparent that it was time to build a new winemaking facility.

Designed in collaboration with Rasmuson, the new winery is a production-only building located next to an existing barn (which housed the old winery) and is capable of producing



Windows provide daylighting into fermentation room, with solar panels on cool roof.

60,000 cases annually, although the 2009 harvest was far short of that. The owners wanted the new winery to blend in with the rural farmland setting, and much of its aesthetic inspiration comes from the adjacent barn.

The winery was designed with a 7,000-square-foot fermentation room that has removable catwalks, three overhead pneumatic punch-down devices, two basket presses, and six closed-top tanks to receive press wine. The fermentation room holds up to 100 movable 3-ton open-top fermentation tanks.

"We designed the winery to optimize open space and artisan techniques," says Rasmuson. "We can highlight our vineyard diversity by working with individual lots of fruit. About 20% of the fruit is cold-soaked between 24 and 96 hours at 55°F. A combination of a 15-ton glycol unit and nighttime cooling achieve the cold soak temperature. The desired maximum fermentation temperature is in the low 80°F, as the 3-ton fermentors do not produce too much heat."

Planning for LEED

LEED is Leadership in Energy and Environmental Design, a point-rating sys-

tem established by the U.S. Green Building Council (USGBC) to determine how many sustainable features are designed into a building. The new winery was to reflect this desire for sustainability.

The design team's task was to go beyond a conventional design approach and find creative solutions and a more holistic approach. In order to achieve as many sustainable features as possible, they involved the entire engineering team from the early stages of design. Currently this project is being reviewed by the USGBC and a gold level rating is anticipated in summer 2010.

Sustainable building elements

The new facility is a rather modest production building, without showcase or hospitality features. It is highly energy-efficient, reasonably inexpensive, durable, and designed to maximize production.

The building is divided into four main zones: administration area in the southwest corner; fermentation area in the southeast corner; tank breezeway in the middle and north of fermentation; and barrel storage on the northern side, with storage and mechanical areas adjacent in the northeast corner. A mobile bottling truck will handle wine bottling.

Rainwater is collected in roof gutters and diverted to a sump, which is then pumped to a pond and later used for irrigation. A 32-kilowatt solar photovoltaic array on the south-facing roof of the fermentation room produces 39% of the winery's energy needs.

All mechanical units, including heating, cooling, ventilation, and refrigeration, were selected to exceed California energy standards, and the overall performance of the building complex was designed to significantly exceed a baseline industrial model.

Night-air cooling is employed to augment mechanical cooling of the barrel rooms and high efficiency lighting is installed — both key factors in LEED certification.

The use of concrete rather than asphalt paving significantly reduces heating of the yard slabs (called heat-island effect).

The winery has a steel frame system provided by Soule Building Systems

Each portable 3-ton fermentor from Custom Metalcraft holds 750 gallons and is designed with a 1:1 ratio. The rugged tank of 304-stainless steel construction has a sloped bottom and tri-clover fitting for discharge. When the tanks are not in use, they can be stacked and stored with a pallet jack or forklift.

Smart Fog in each barrel room is programmed for 10-second dispersal every 30 seconds. System activates within 2% of setpoint (75% humidity).

Six blending tanks in breezeway between fermentation room and three barrel cellars.

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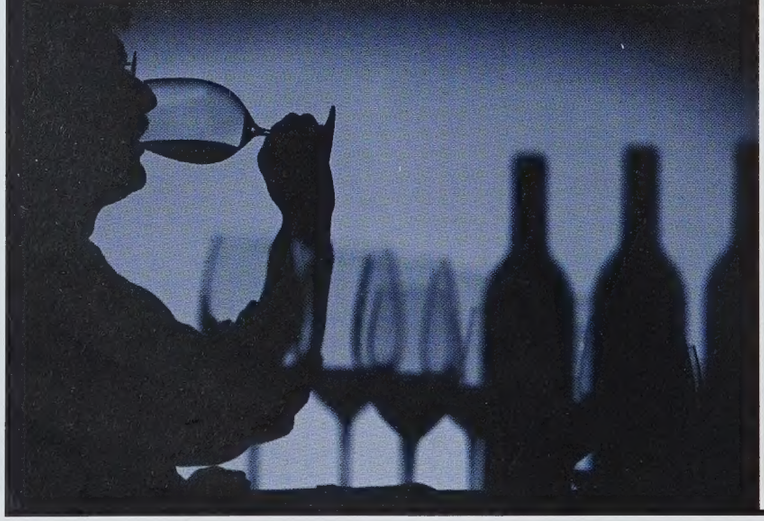

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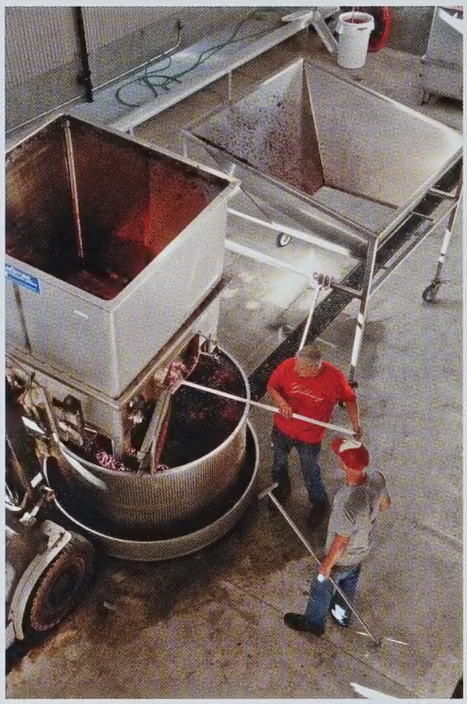
(Cotati, CA), who also installed metal-clad insulated wall panels. Steel construction is very efficient for the long spans desired for wine production facilities. Numerous benefits include cost efficiency, minimal maintenance, and ease of construction. As an additional benefit, steel is a material that has 80% of its content recycled.

The fermentation room experiences a high volume of forklift and pallet-jack traffic with portable fermentors being moved in and out during harvest. Four-feet high concrete perimeter walls allows for durability, low maintenance, and easy hose-down for cleanliness.

Natural daylight eases task visibility while promoting comfort and well-being for workers. In winery design there is a delicate balance between the value of natural light and a reduction of heat gain, especially in the barrel rooms where a high thermal containment is necessary. At the new winery, the "cool roof" feature reflects nearly as much heat as it absorbs, which lessens heat gain for the building.



Fermented Pinot Noir grapes discharged from fermentor into basket for pressing.

All building materials were selected for the absence of toxic volatile compounds and to provide a careful balance of industrial utility with energy economy. In addition to all the sustainable features of the new winery, 98% of all construction waste from the project was recycled during construction.

Energy efficiency

To qualify for a LEED rating, a building has to meet or exceed several standards. The building energy analysis of the new winery consisted of looking at the three main building components comprising most of the building's energy usage: the building's envelope, lighting systems, and mechanical systems.

"Winery projects are a mix of commercial and industrial uses," explains Kevin Gilleran of Gilleran Energy Management (Santa Rosa, CA). "The USGBC LEED program requires that all

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energy used at a new facility be included in the energy analysis process."

The analysis of the Goldeneye Winery found its annual energy use includes the following areas:

- Office/lab area (covered by state energy code): 21%
- Lighting in barrel and fermentation areas (covered by state energy code): 39%
- Process energy use — fermentation cooling, barrel building refrigeration, lighting in work areas (not covered by code): 40%

"Process energy use in the Goldeneye project accounts for at least 40% of the anticipated annual energy use and is not allowed to be part of the energy savings program, according to the USGBC, primarily because there is no recognizable standard against which energy savings can be compared," adds Gilleran. "This may change soon because the California Energy Commission is now regulating refrigerated buildings.

"The barrel building has an integrated night cooling system supplemented by an air-cooled direct expansion refrigeration system. This is an innovative way to cool buildings that operate in a temperature zone that can be cooled by night air. The barrel building will be maintained between 55° to 65°F year-round. Night-air cooling is a perfect match for this need.

"Energy savings, according to the USGBC, can only be taken in the areas covered by an energy code, either California's State Code or the ASHRAE 90.1 standard. Energy savings for this project came from the following areas: high efficiency lighting, lighting controls (occupancy sensors and daylighting controls), a well-insulated envelope, high-performance glass, and high-performance air-cooled mechanical systems.

"The energy savings for the high-efficiency measures accounted for about 8% of the total project energy usage. In anticipation of this issue, the project installed a solar photovoltaic renewable energy system that offsets an additional 39% of the annual energy usage.

"A winery with none of the above energy efficiency measures or renewable energy would have about $22,000 in annual energy costs. Goldeneye Winery's annual energy costs, after implementation of the above measures, is anticipated to be about $11,609, for a reduction of about 47.4% in annual energy usage."

Goldeneye received a rebate from the federal government for installing the solar electric system. The rebate came from the 2009 American Recovery and Reinvestment Act that gave back 30% of the total cost of the system (cash rebate in lieu of tax deductions). A 12% rebate came from the California Solar Initiative, for a total 42% offset for the cost of the system.

The building's envelope refers to the type of construction and insulation levels for the walls and roof, and type of construction of windows and doors, including any high-performance glazing.

Project employs high levels of insulation:

a. Barrel Rooms, panelized walls: R-37
b. Barrel Rooms, panelized roof: R-35.8
c. Fermentation Room panelized walls: R-18.8
d. Fermentation Room panelized roof: R-24
e. Office Area framed metal walls: R-21
f. Office Area panelized roof: R-24
g. Windows and doors: Metal-framed system with double-pane low-e PPG Solarban 60 glazing

Lighting systems included the following measures:

h. High performance T-8 or T-5 light fixtures with electronic ballasts
i. Controls that will automatically turn off some of or all lighting when the space is not in use. The system typically uses an occupancy sensor and, as needed, a photocell sensor to turn off lighting during the day when daylight is available and adequate.

Heating, cooling, ventilation, and refrigeration systems:

j. High-efficiency split-system heat pumps for the office and lab areas.
k. Split system cooling-only refrigeration systems for barrel rooms. This area only

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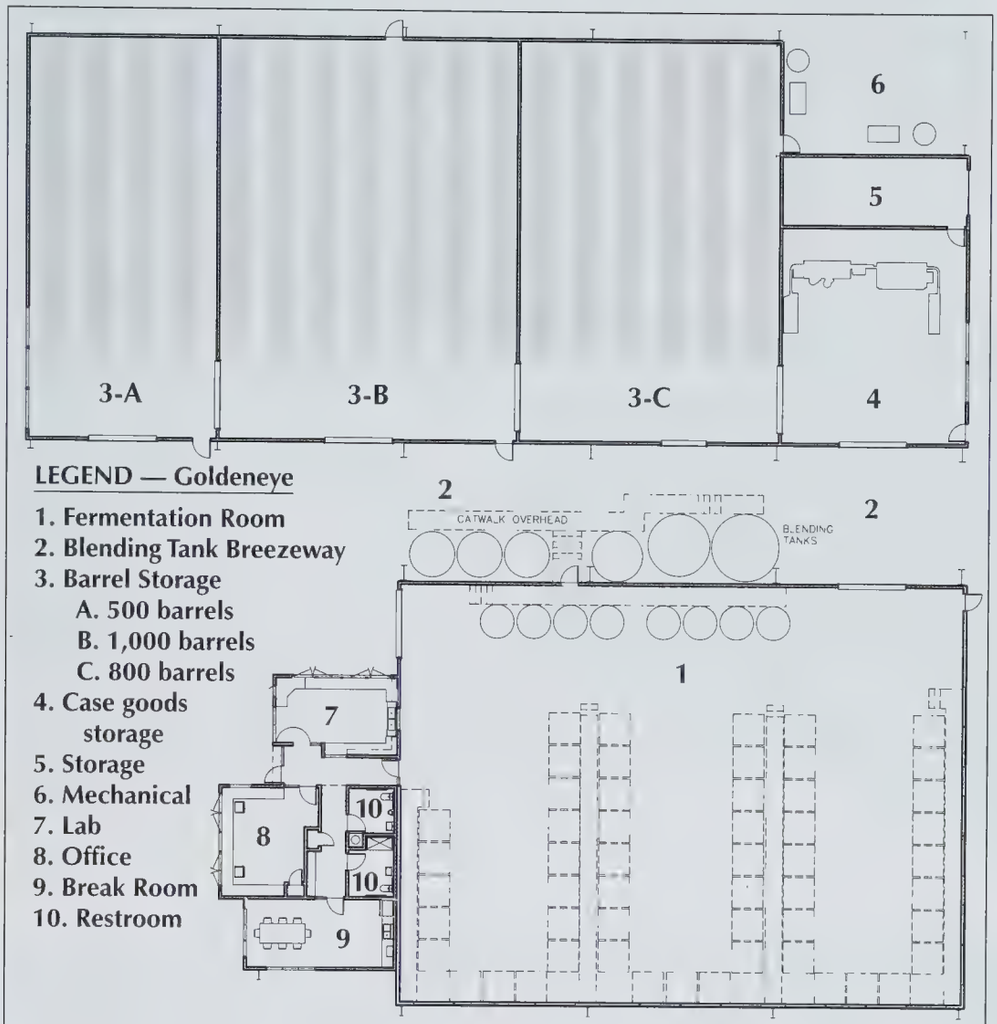

Blending tank capacities: two-14,000 gallons, one-10,000 gallons, two-7,000 gallons, one-4,800 gallons.

uses the refrigeration when needed to backup the integrated night cooling system.

Analysis of the building indicates that the project meets and exceeds national and local codes by at least 14%. As noted above, the solar electric system, 32 kW DC power, is predicted to produce about 39% of the annual energy usage.

FSC-certified wood

Much of Goldeneye Winery's aesthetic inspiration comes from the adjacent historic barn that was the original winery. One of the earliest barns in Anderson Valley, it is made entirely of old-growth redwood, milled from trees harvested not far from where it has sat for over a century.

Goldeneye wanted the new winery to complement the original barn and blend into its rural farmland setting. The redwood siding is certified by the Forest Stewardship Council (FSC) and was harvested from estate land owned by Goldeneye. The trees were locally milled, stickered, and cured four years prior to construction.

Exterior siding materials were chosen to complement one another in a beautiful, earth-friendly, and utilitarian way. By using redwood board and batten siding adjacent to corrugated metal, interesting shapes and contrasts were created. The objective was not to allow one material to overwhelm another, but rather to have them complement each other in combinations — natural with manufactured, warm with cool, and random with controlled.

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were prime criteria to achieve approximately 75% humidity in the barrel rooms. The "Smart Fog" system (www. smartfog.com) was selected because it is virtually silent, does not need concurrent fan operation, and will be virtually drip-free (if maintained per factory specifications). Dry fog uses reverse osmosis (RO)-treated water (the system is furnished with an RO-generator and storage tank) at line pressure, and compressed air to pulse a cool fog from the distribution nozzles. The compressed air provides the motive force for fog distribution.

"Cooling of the barrel rooms is accomplished via single-zone air-cooled condensing units and unit coolers (a direct expansion or cooling system)," explains Rob Main of TEP Engineering (Santa Rosa, CA). "Each barrel room has two unit coolers and one condensing unit. The condensing units have an option for recovering heat for a future hot water pre-heating system.

A comparison of the operating efficiency, reliability, and performance of the direct expansion cooling system to a glycol system determined that the direct expansion system was superior in all categories.

"The barrel rooms have night-air cooling and CO_2 exhaust systems. The night-air cooling (NAC) system takes advantage of the cool nighttime ambient conditions to provide 'free' cooling to the barrel rooms. Typical fall conditions will allow passive NAC to 58°F. The CO_2 exhaust system evacuates CO_2 produced during fermentation."

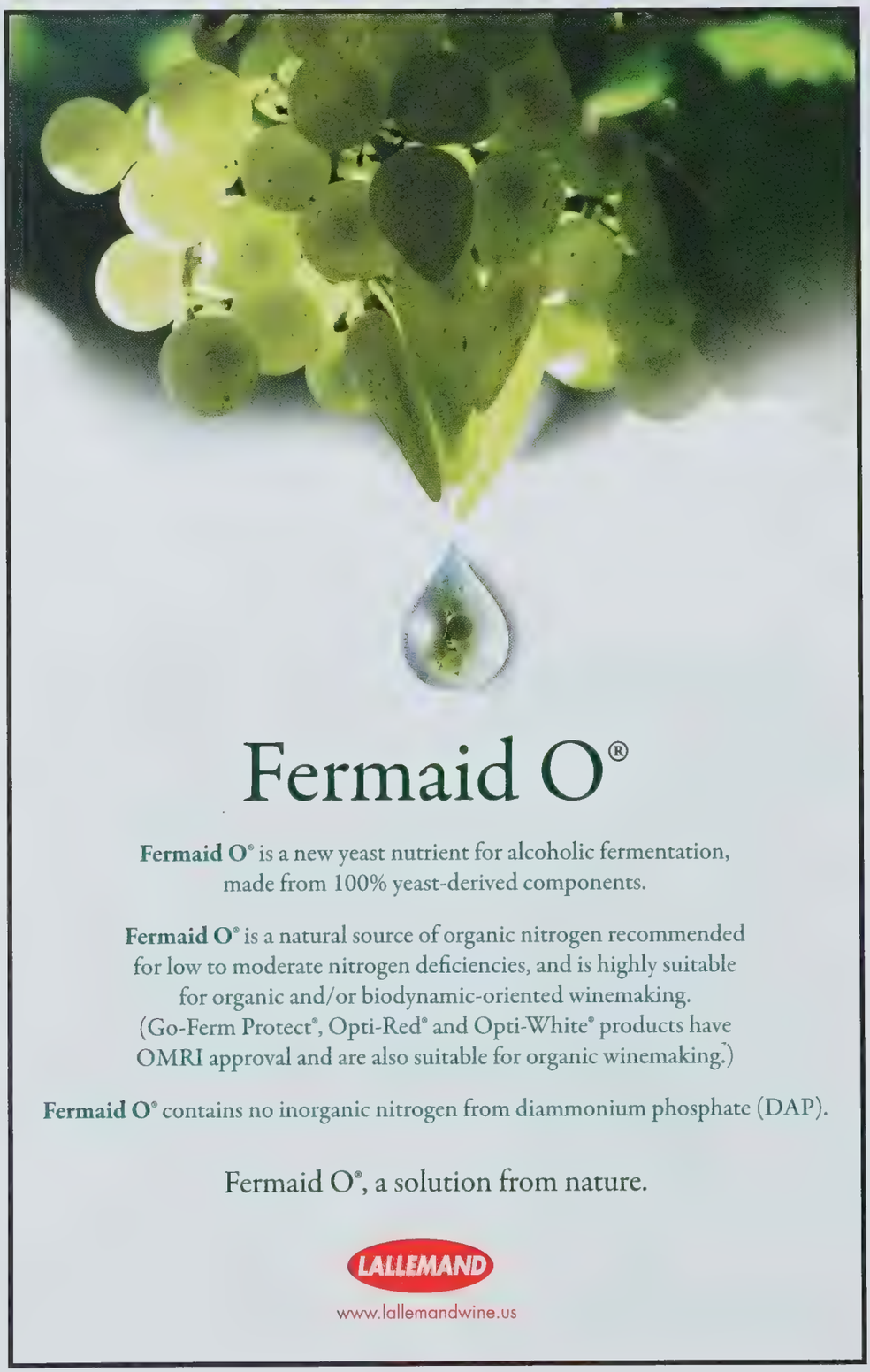
"Malolactic fermentation occurs in barrel," adds Rasmuson. "We aim for 68°F and utilize passive warming by manually turning on the intake fans during the warmest part of the day. We do not rack any Pinot Noir in barrel until bottling. We top the barrels monthly."

The office and lab are heated and cooled via split system heat pumps. The heat pumps were used to take advantage of the site-generated power via the solar electric system.

Conclusion

Will a LEED winery somehow improve wine quality? "The short answer to this question, in my opinion, is yes," replies Mike Lucia, assistant winemaker. "It is not just the new 'toys' or equipment which are great, that give us a remarkable degree of responsiveness and flexibility — though the fundamentals of our winemaking style remain unchanged. The overall morale of the production team has increased dramatically because we feel we are a part of something very special.

"The new winery has given us a sense of awareness in our environment and a greater connection to our Gowan Creek Winery. What I am witnessing now is an increased level of personal ownership from everybody on our crew. In turn, that individual connection is affecting and touching the wine on a more harmonious level." ■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Lauren Klopp maps Pinot Noir cluster exposure in Russian River Valley (California). Light levels in the fruit zone (measured by the sensor bar) are measured simultaneously with ambient levels (received by sensor in the left hand) to obtain a canopy calibration used in exposure mapping.

DETERMINING optimal cluster exposure IN YOUR VINEYARD

BY James M. Meyers,
Justine E. Vanden Heuvel,
Cornell University,
Ithaca, NY

Imagine for a moment that it is 2:30 PM on an unusually hot summer afternoon. Now ask yourself: Do you know where your clusters are? Are they tentatively tucked away behind a leaf or two, nervously riding out the onslaught of solar radiation? Or (gasp!) might they be literally hanging out to dry while being ravaged by sunburn?

As a good viticulturist, it is likely that you have established viticultural practices that can safely guide your fruit toward its anticipated potential and have a good idea of how the clusters might fare under such conditions.

You may even be so confident in your canopy management practices that you are thinking about skimming along to the next article. But please read further.

You may find that, despite your diligent efforts to understand and take control of your canopy architecture and microclimate, you are not as informed as you deserve to be.

Canopy architecture targets improve understanding and quality

If avoiding sunburn were the only concern, life in the vineyard would be simple. Everyone would simply implement the trellising and training systems that best facilitate vine balance within their chosen cultivars and sites. Few growers would meticulously position shoots or obsess over leaf pulling. But attaining proper canopy architecture is not so simple.

Avoiding sunburn is important, but so is reducing disease pressure and development of flavors and aromas — each of which requires some level of sunlight exposure to the clusters.

How much sunlight is really needed? The answer to that question is site-specific and depends on what grape variety you are growing, where you are growing it, and what wine you are trying to produce.

All growers are well aware of what they are growing and most have a good handle on their site-specific chal-

Proper EPQA measurement technique: First contact by dowel from insertion-side of the canopy to a cluster is noted (letter 'C') and then cluster is gently moved aside to complete the measurement. The dowel passes the canopy center (letter 'W' for wire) before contacting a leaf ('L') on the exit-side, resulting in a measurement of 'CWL' for this location.

lenges. However, a deliberate flavor and aroma profile is difficult to define and even more difficult to control.

As a result of this uncertainty, cluster sunlight exposure is generally managed toward one of three broad targets:

"maximum exposure," in which clusters are given as much exposure as possible, short of burning;

"minimum exposure," where clusters are given only the minimum amount of exposure needed to minimize disease pressure; or

"somewhere in between."

Growers striving to produce ripe, fruit-forward, deeply colored red V. *vinifera* in New York state seek maximum exposure for grapes. Growers attempting a crisp white aperitif in California's Central Valley would likely strive for minimal exposure. But those who manage their fruit production for consistency and subtle brand-distinction, while also working within the generally recognized constraints of their chosen cultivars and growing region, are looking for "somewhere in between."

While this broad "somewhere in between" target for cluster exposure may lack a certain authoritative satisfaction, it has remained the state-of-the-art in canopy management for quite some time. The truth is that managing your vineyard toward broad targets is still far better than not setting any targets at all.

Dr. Richard Smart pioneered the use of architectural targets in 1979 when he introduced **point quadrat analysis** (PQA) to assess canopy architecture and suggested quantitative targets for PQA metrics such as mean **leaf layer number** (LLN), **percent gaps** (PG), and **percent interior clusters** (PIC).

Dr. Smart's insights into the quantitative relationships among microclimatic canopy architecture parameters, vine performance, and fruit quality were timely and innovative. Accessible to any grower or researcher, these techniques offer a high level of precision and utility.

Many of the world's vineyards continue to be guided by the canopy architecture targets suggested by Dr. Smart or by models derived from his early work. By setting targets, managing toward them, and evaluating their ultimate effect on fruit quality, a grower can learn a great deal about the current performance and future potential of his or her vineyards. A historical record of architectural canopy data and fruit quality, collected over several seasons, can accurately guide a grower toward ideal targets.

Small canopy differences can have a big impact

Dr. Smart's canopy evaluation methods were ahead of their time. To date, our understanding of the quantitative relationships between canopy architecture and fruit chemistry have been constrained by a limited ability to

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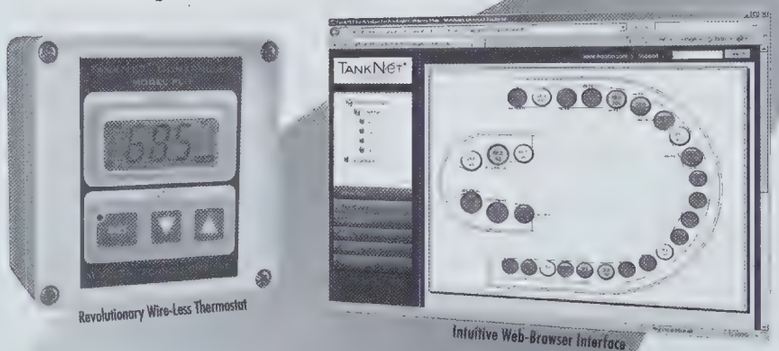

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identify and quantify low-concentration chemicals relating to fruit quality. Recent advances in the fields of flavor and analytical chemistry have opened the door to a new era in understanding.

Chemical analyses are now able to detect extremely small differences in the relative concentrations of key flavor and aroma compounds. As a result, viticulturists are beginning to find that their field tools are now the limiting factor in quantifying the relationships between canopy architecture and wine quality. Consider the following example:

A recent collaborative study between our lab at Cornell and that of Dr. Gavin Sacks (also at Cornell) revealed that levels of key flavor and aroma compounds can vary by a wide range — even among vines within the same vineyard block and grown with identical cultural practices.[1] Although the vines visually appeared to be similar, they produced fruit with significantly different chemical profiles.

Table I: Summary of PQA and EPQA terminology

	Metric	Abbreviation	Description
Traditional Point Quadrat Analysis (PQA)	Leaf Layer Number	LLN	Average number of leaves across canopy row. Measures canopy fill.
	Percent Gaps	PG	Percentage of point quadrat measurements that made no contact. Measures canopy fill.
	Percent Interior Cluster	PIC	Percentage of clusters that are behind at least one leaf. Measures cluster exposure in binary terms (inside or outside the canopy shade).
Enhanced Point Quadrat Analysis (EPQA)	Cluster Exposure Layer	CEL	Average number of shading layers between a cluster and nearest canopy boundary. Measures cluster exposure in terms of canopy depth.
	Canopy Cluster Symmetry	CCS	Ratio of shading layers between clusters and either side of canopy row. Measures directional bias in cluster exposure.
	Trellis Contact Symmetry	TCS	Ratio of shading layers on either side of the canopy centerline. Measures directional bias in shoot position.
EPQA + Cluster Exposure Mapping (CEM)	Cluster Exposure Flux Availability	CEFA	Average percentage of full sunlight that reaches clusters. Measures cluster exposure in terms of available sunlight.
	Cluster Exposure Flux Symmetry	CEFS	Ratio of sunlight that reaches clusters from either side of the canopy row. Measures directional bias in cluster sunlight intensity.

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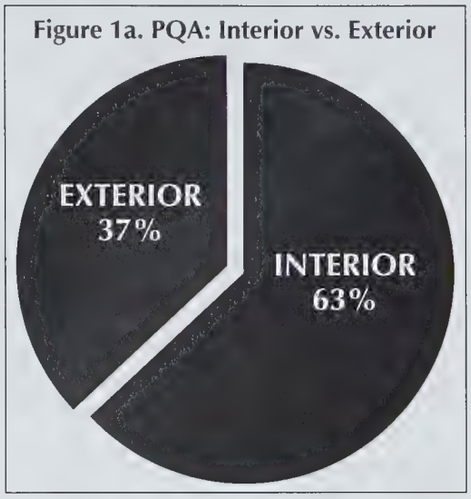

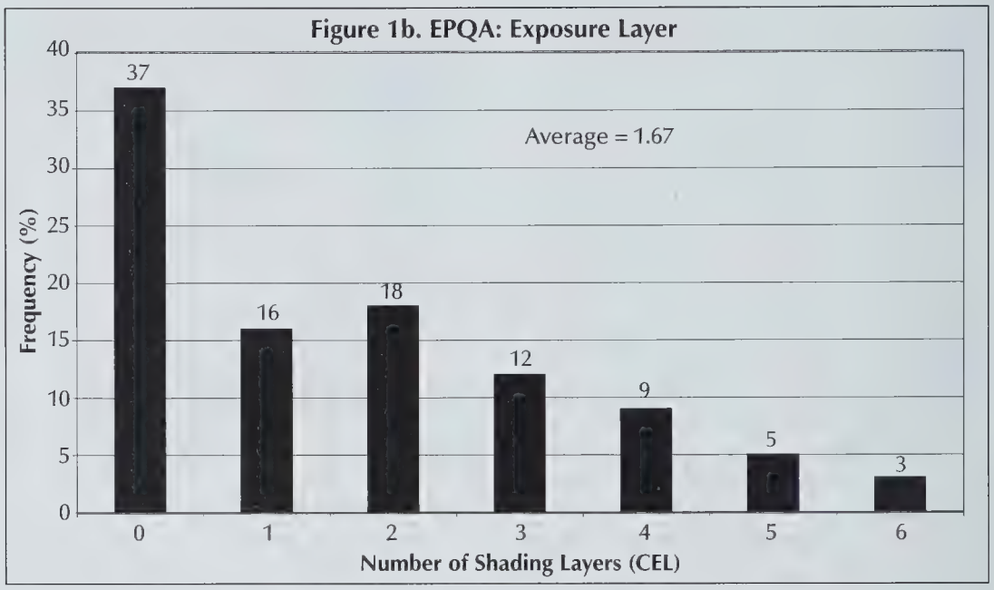

Figure 1 compares cluster exposure metrics in PQA to EPQA.

Of particular interest is that, among nine randomly selected four-vine panels of Riesling, the compound b-damascenone (which has been reported to enhance ripe fruit characteristics, and thus mask perception of herbaceous aromas) was produced in must at a wide variety of concentrations with the highest concentration about 2.5X greater than the lowest concentration.

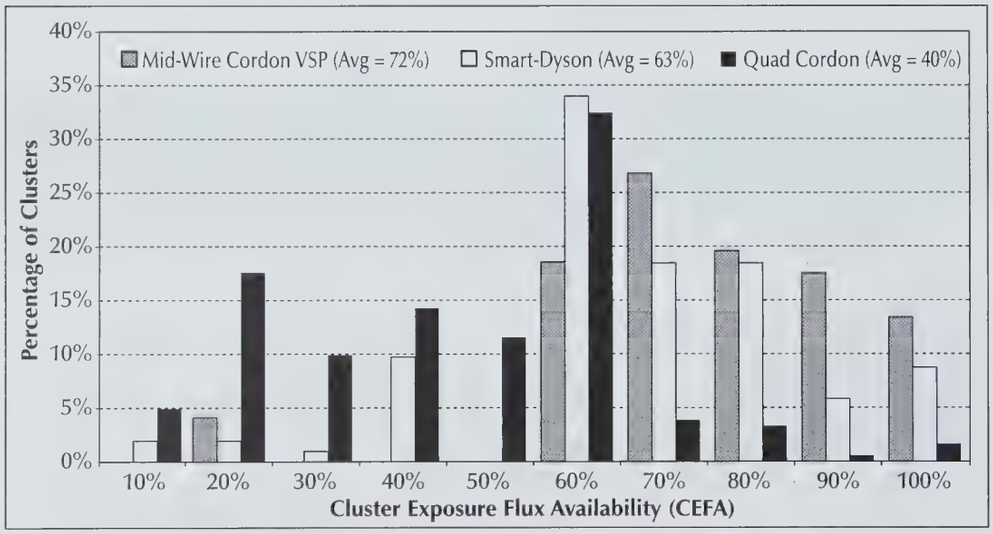
Mid-Wire Cordon VSP (Avg = 72%)
Smart-Dyson (Avg = 63%)
Quad Cordon (Avg = 40%)
Percentage of Clusters
Cluster Exposure Flux Availability (CEFA)

Figure 2. Comparison of cluster exposure among three training systems at Shone Vineyard, Santa Rosa Junior College (SRJC), Sonoma County, CA. Data provided by Merilark Padgett-Johnson, SRJC viticulture instructor.

Although PQA was able to reveal subtle microclimatic differences in canopy architecture and cluster exposure, no statistically significant relationship was found between the traditional cluster exposure PQA metric for cluster exposure (PIC), and the variation among vine panels in fruit b-damascenone concentration. However, when our recently developed "**enhanced point quadrat analysis**" (EPQA) computational model[2] was applied to PQA data, the variation in b-damascenone response could be partially explained by differences in cluster exposure.

Although the PIC did not have the sensitivity to reveal the relationship, the new metrics known as **cluster exposure layer** (CEL) and **cluster**

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exposure flux availability (CEFA) were able to show small differences in fruit microclimate among the vine panels and uncovered a strong relationship between both the depth of clusters within the canopy and differences in light penetration through the canopy layers. Table 1 has a summary of all PQA and EPQA metrics discussed.

Quantifying canopy variability with EPQA and exposure mapping

The primary difference between PQA and EPQA is that EPQA metrics are more precise in their measurement of canopy spatial structure. For example, the PQA metric for cluster exposure (PIC), expresses cluster shading as the percentage of clusters that are not on the outermost canopy layer. With PIC, a cluster is either shaded or exposed. In comparison, the EPQA metric CEL expresses cluster exposure as the number of shade producing contacts between a cluster and the canopy exterior.

This distinction is useful to grape growers because there is a substantial difference between a cluster behind only one leaf and a cluster behind four leaves. Figure 1 demonstrates the difference in sensitivity between PIC and CEL. It is this increased sensitivity in canopy spatial structure that found the previously mentioned relationship between cluster exposure and b-damascenone. Counting clusters as simply being either interior or exterior masks vital information about the subtle differences in cluster sunlight exposure.

This additional information about the precise position of clusters can be used to create a **cluster exposure map**. This is done by using a light meter to measure the amount of sunlight that reaches the center of a canopy under full sunlight when the sun is directly overhead. By combining this information with the precise location of each cluster within a canopy (as measured by EPQA), a map of CEFA values can be computed that determines the precise amount of sunlight that each cluster is receiving.

The previously mentioned relationship between cluster exposure and b-damascenone was statistically most significant when looking at CEFA.

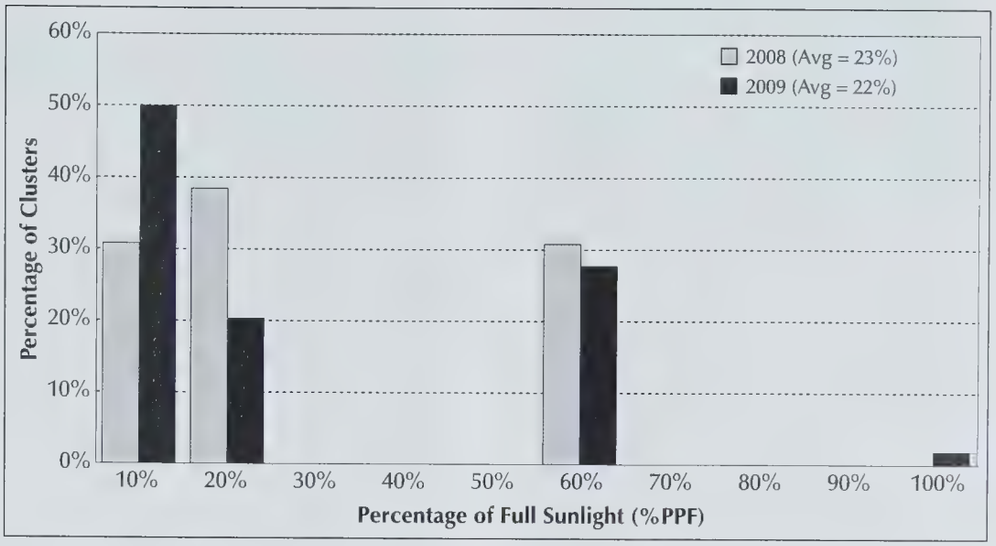

Figure 3. Comparison of cluster exposure in two consecutive years as measured in a sentinel panel in a New York Riesling vineyard.

CEFA is even more precise than CEL, providing more sensitive measurement of sunlight exposure and variability within a canopy. CEL improves on the precision of PIC by keeping track of cluster canopy depth, and CEFA further improves on the precision of CEL by determining how much sunlight is available at each canopy layer within a given vine.

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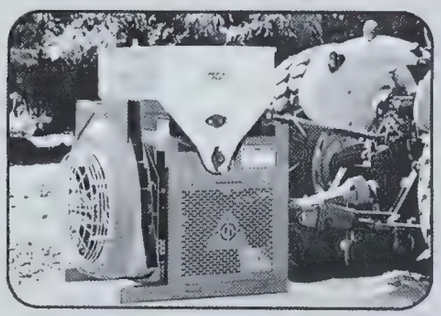

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Figure 4. Using a wooden dowel to collect canopy PQA data.

Sunlight intensity varies throughout the day as the sun moves across the sky, but the mid-day canopy calibration establishes a measure of how sunlight penetrates into the deeper canopy layers. This information is used to calculate how much sunlight is available, on average, at any given point in the fruit zone.

Figure 2 demonstrates the use of cluster exposure maps to compare the effect of different canopy architectures on fruit exposure in a California Syrah vineyard. The maps in Figure 2 illustrate the effect of training system on both average cluster exposure and exposure variability. The mid-wire cordon VSP system provided the most sun exposure and the least variability, while the horizontally divided quadrilateral cordon system offered the least average sunlight exposure but also the most variability.

Figure 3 demonstrates the use of cluster exposure maps to compare the yearly differences in cluster exposure within a single four-vine sentinel panel of Scott Henry VSP trellis in a New York Riesling vineyard. While the grower achieved the same average cluster exposure in 2008 and 2009, there were differences in exposure variability between the years, as demonstrated by the percentage of completely shaded clusters (30% in 2008 compared to 50% in 2009).

It should be noted that the level of measurement precision provided by EPQA is currently not achievable with electronic imaging tools. Techniques like aerial normalized differential vegetation index (NDVI), or even tractor-mounted NDVI cannot determine cluster position and sunlight exposure with enough precision to replace manual data collection required for EPQA. Technology will eventually find ways to achieve a similar level of spatial precision, but for now, the data must be collected the "old fashioned way."

There is a spreadsheet tool available that will compute all of the metrics for you. You need to collect the PQA data, type it in, and record the computed results. E-mail jmm533@cornell.edu to receive a free copy of the spreadsheet.

Leaf removal only near highly-shaded clusters reduces exposure variability. Indiscriminate removal along the canopy row may not reduce variability, and can over-expose clusters.

Acquiring a better cluster exposure target than "somewhere in between"

A cluster exposure target of "somewhere in between," even a specific numerical target, is not synonymous with the concept of "optimal cluster exposure" in the title of this article. Proper optimization is a methodical, iterative, and highly quantitative process — something that is quite rare in production agriculture. However, you can begin the process of optimizing cluster exposure today in your vineyards. Once you learn the method, you will become your own best researcher as you begin to think about your vineyards with a renewed sense of subtlety and precision.

Here is how to begin:

1. Map the large scale variability in your vineyard based on slope, aspect, and soil differences. You may have done this when you initially blocked your vineyard. If you know that you have variability within a block, make note of that and treat the areas of difference as unique blocks.
2. Choose three sentinel panels of at least four contiguous vines or 20 feet of canopy row, whichever is longer, for each of your blocks. Sentinel panels represent the canopy of the entire block — you will measure these panels for comparison with other blocks. It is important to use entire panels because the structure of a canopy row is more complicated than that of a single vine. Measuring single vines does not reveal the whole picture and increases the risk of choosing vines that do not represent the rest of the block.
3. Measure your sentinel panels using PQA, as described by Dr. Smart in *Sunlight Into Wine*. More details on how to collect the data are included with the spreadsheet, but the general approach for collecting data from a sentinel panel is as follows:

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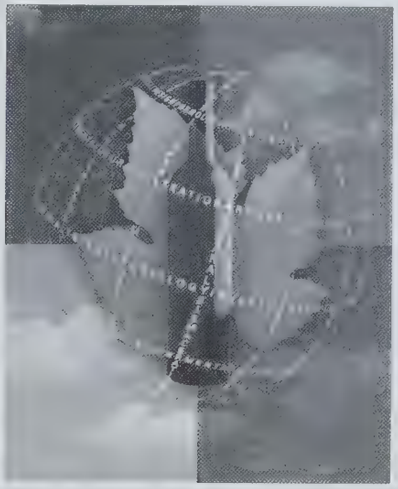

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Figure 6. Sample vineyard data log

Block	Sentinel	Vines	PQA Interval	Panel Length	Training System	Established Targets
Pinot North	Row 15 Panel 33	4	8 inches	26 feet	Flatbow VSP	CEFA = 60% at fruit set, 35% at veraison; CEFS = -0.04 (4% bias to east); Shoots = 11/ft = 286/panel; post-harvest cane wt = 1.25 ounces

		ENHANCED PQA AND CLUSTER EXPOSURE METRICS									ADDITIONAL PANEL DATA			
	Phenological Stage	PQA				EPQA			CEM		(add to these columns to suit your practices)			
		LLN	PIC	PIL	PG	CEL	CCS	TCS	CEFA	CEFS	Shoots	Clusters	Notes	Action plan
Fruit Set	Initial measurement	3.2	50%	56%	12%	1.5	0.05	–0.1	48%	0.04	390	790	Shoot density is higher than target	Thin to target of approx. 11/ft
	Follow-up measurement	2.8	41%	39%	16%	1.2	0.02	0.05	63%	0.05	270	440	Cluster exposure is near target of 60%	No action required
	Follow-up measurement													
Veraison	Initial measurement	3.0	66%	60%	5%	1.6	–0.15	–.2	22%	–0.12	—	—	Exposure below CEFA target of 35% and biased to uphill side due to shoot positioning	Pull leaves; more from downhill side approx. 25% from fruit zone on uphill, 50% on downhill
	Follow-up measurement	1.3	24%	50%	10%	0.8	0.05	–0.1	34%	–0.06	—	—	After leaf pulling, more exposure and better symmetry	Hedge as needed. Measure after first hedging.
	Follow-up measurement	1.2	25%	48%	9%	0.8	0.04	–0.11	35%	–0.05	—	—	Hedging maintains cluster exposure	No need to measure again this season
	Harvest												10% sunburn—too much leaf pulling?	Reduce next CEFA veraison target to 30%

	VINEYARD NOTES	WINERY NOTES	ACTION PLAN
Post Harvest	Average cane weight of 1.4 oz. higher than target of 1.25 oz.	Some cooked fruit aromas noted in unblended wine. Lowest acid of all Pinot blocks	Adjust target shoot count to 12 per linear foot to push cane weight lower, but watch for changes in fruit-set cluster exposure. If necessary, use fruit-set leaf pulling to maintain 60% CEFA target. Winery confirms plan to reduce veraison CEFA target to 30%.

• Find someone to help you write down the data, or use a voice recorder, and go into the vineyard. Choose one side of the canopy from which you will take measurements. For consistency, you should always measure from the same side of the canopy.

• Starting at the left-hand trellis post, slowly insert a wooden dowel through the canopy at the height of the fruit zone. Always keep the rod parallel to

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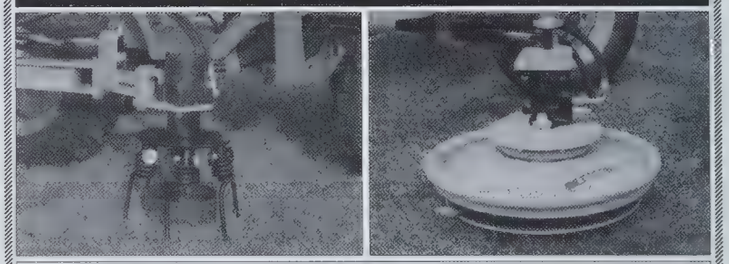
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the ground and perpendicular to the canopy row (see Figure 4). As the dowel moves through, record what you contact. Use your free hand to move leaves and clusters out of the way — you want to record what the dowel would have hit if it passed straight through, without damaging leaves and clusters.

- For each insertion, as you make contacts, record an 'L' for a leaf and a 'C' for a cluster. Shoots or stems are ignored, because they do not contribute to the canopy light environment to the extent that leaves and clusters do, but feel free to record them if you have a desire to keep track of stem contacts. Future EPQA metrics may take them into account.

When the rod reaches the intended centerline of the canopy, record a 'W.' Recording the "wire" enables the calculation of trellis symmetry metrics. Note that you only record 'W' once for each insertion and that you are not actually recording the location of a physical wire, but location of the canopy center (center of the trellis post). If the dowel does not touch any leaves or clusters, just record a 'W' to note the location of that gap.

- Repeat this measurement approximately every 8 inches until you reach the end of the 4-vine panel. You may choose any consistent interval (such as 6 inches, half of your boot, etc.) as long as you are always consistent. 20 cm is the recommended interval, and used by most researchers, if you are comfortable with metric measurements. A measuring tape on the vineyard floor is a good way to maintain consistency.

4. Record data at fruit set and veraison into the spreadsheet. Maintain a log with the date, 4-vine panel location, and computed metrics (copied from spreadsheet). Refer to Table 1 for a summary of these metrics. At a minimum, you should record the traditional PQA metrics (LLN, PIC, PIL, and PG), the EPQA metrics specifically related to cluster exposure (CEL and CCS), and the EPQA metric related to trellis symmetry known as **trellis contact symmetry** (TCS).

The spreadsheet does the calculations for you and describes precisely what each metric represents. Undoubtedly, there are many consultants who would be willing to help get you started. Depending on what you find, you may need to take some follow-up measurements (to check the effect of leaf pulling, shoot thinning, etc.).

5. If possible, it is highly recommended that you also calibrate your canopies with a light bar so that you can produce cluster exposure maps and compute values for CEFA and **cluster exposure flux symmetry** (CEFS). Canopies with similar layering may still have significantly different light environments resulting in different cluster exposure profiles. PQA

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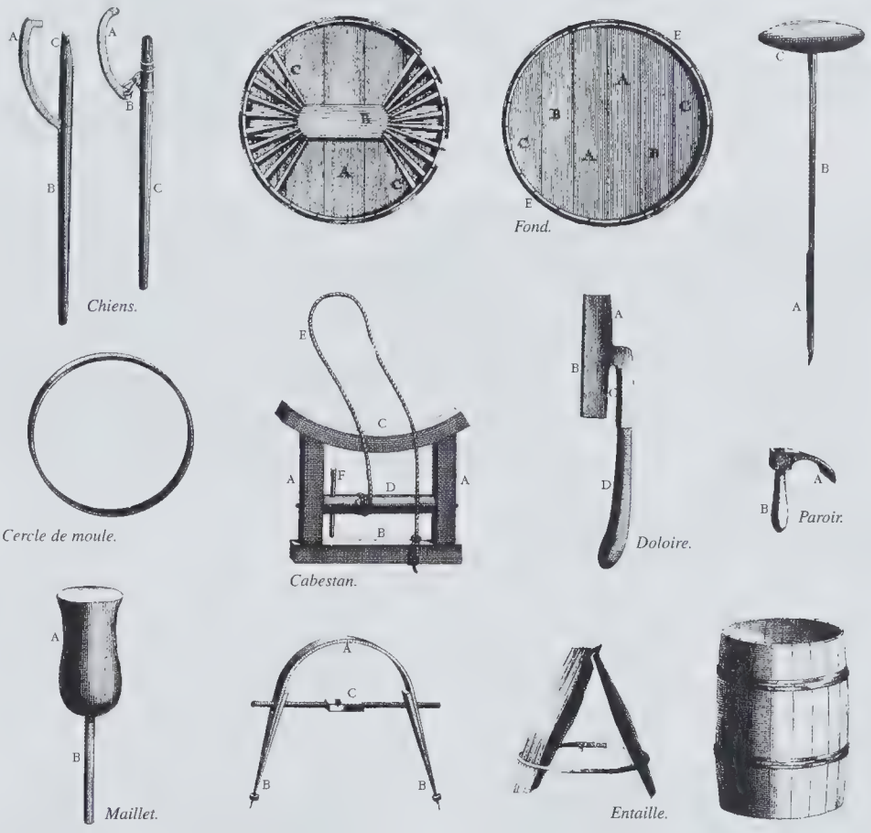

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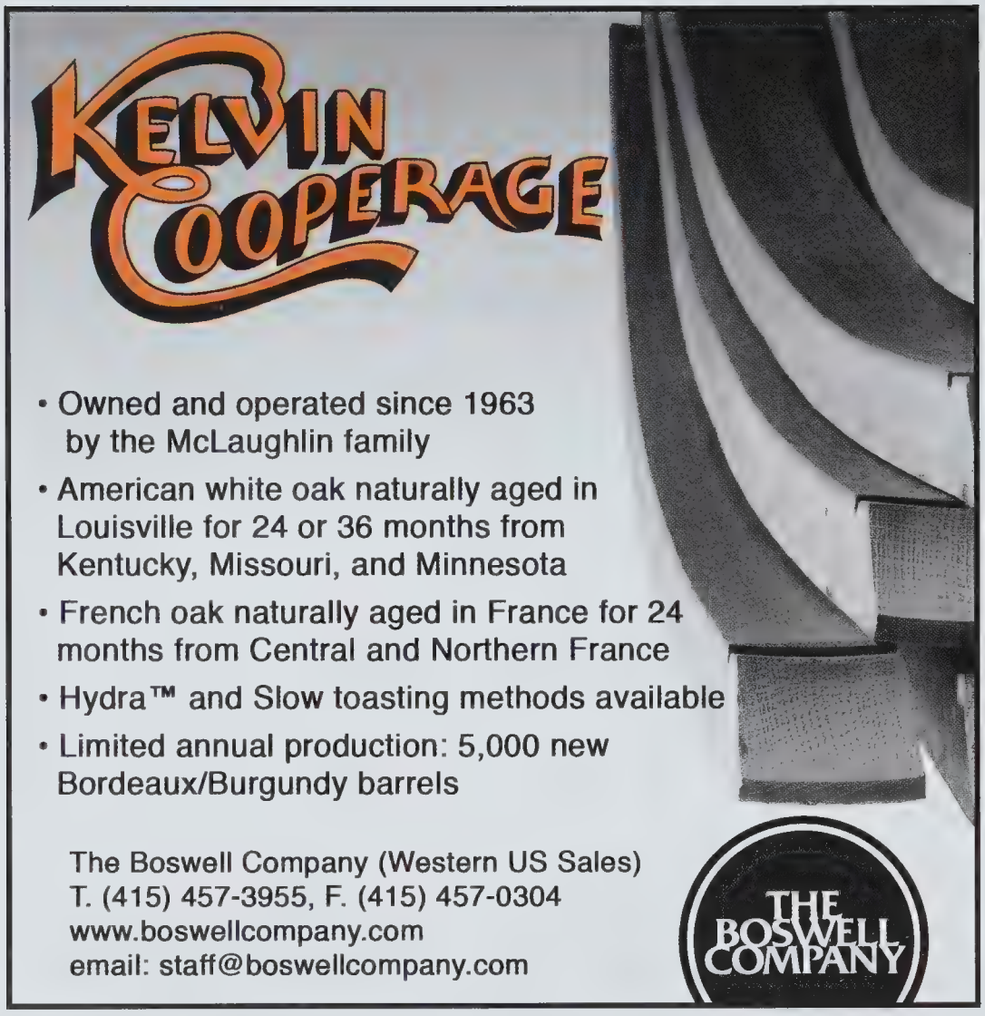
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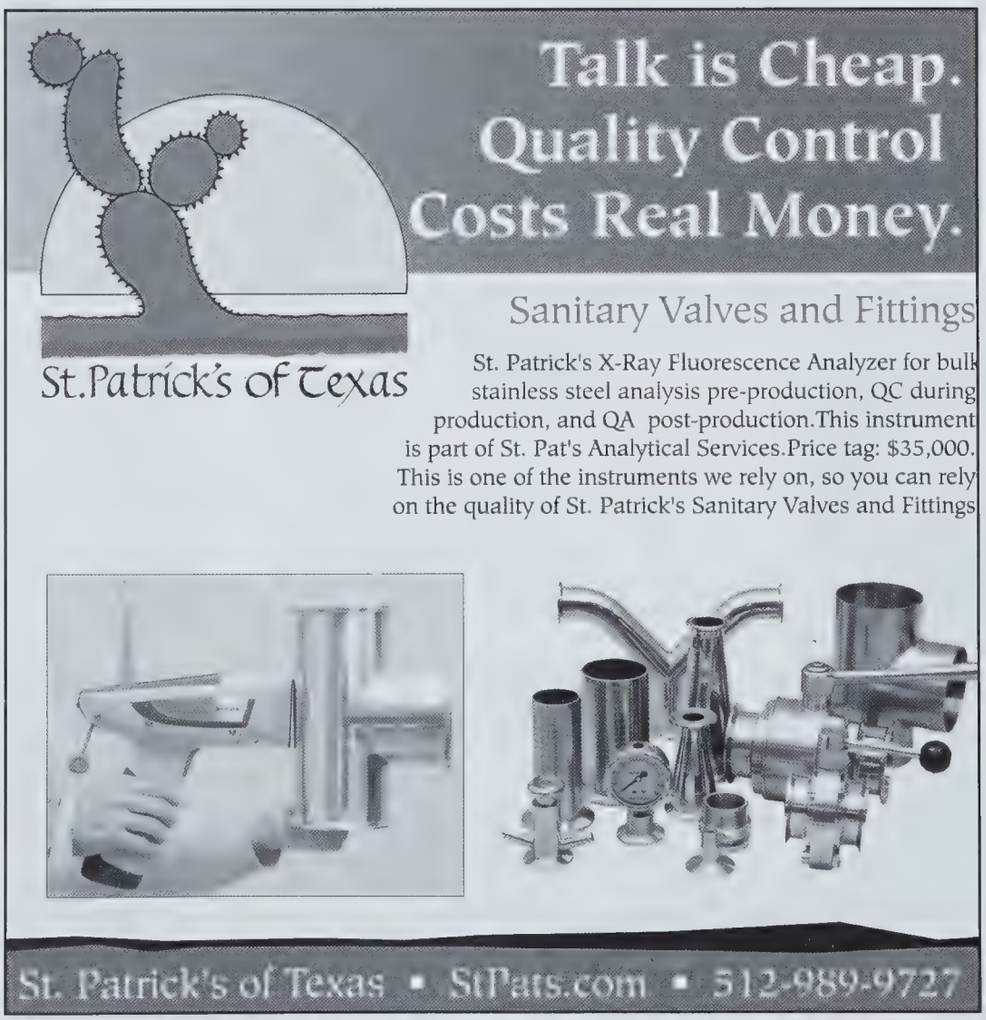
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insertion data alone will not reveal these differences. A consultant might be a good fit here if you do not want to invest $3,000 in a light bar.

Figure 5 demonstrates the proper way to calibrate the canopy — the light bar is placed inside the canopy, along the centerline, at fruit zone height, with the sensor positioned parallel to the ground and facing directly overhead. An external sensor, as demonstrated in Figure 5, can be used to simultaneously measure light both above and inside the canopy.

6. Record performance data from each sentinel panel. Here is where you become your own researcher by deciding what quality and performance metrics are most important to you. Some examples of vine performance metrics might include items like bud count, shoot count, cluster count, pruning and shoot weights, sun damage, and disease severity. Figure 6 provides a sample log that you can extend to suit your practices.

Enologically, you may want to record measures of °Brix TA, and phenolics. Use numbers wherever possible, but you should also record qualitative observations about vine performance, fruit, and wine quality.

Tasting notes (both for fruit and finished wines), vineyard commentary, and photos are all good examples of the type of data that you want to record. Be sure to record data separately for each sentinel panel and base your performance data on the entire panel, not just on a few berry or cluster samples. Small differences in cluster exposure affect quality. There is no real "average" cluster within a panel.

7. Analyze the data. Which blocks performed best according to your standards? Compare the numerical metrics among the blocks to see how differences in canopy architecture may have influenced performance.

Do the results suggest that you want to manage some blocks toward a favorite target? The "notes" column in Figure 6 provides some simple analysis examples. These decisions are not always easy. You may find that the cleanest fruit was also your most sun-damaged, or that your favorite flavors

Continued on page 58

SAUVIGNON BLANC

IMPACT OF FINING TREATMENT ON JUICE QUALITY

BY **Paul K. Bowyer (Technical Manager, Laffort Australia), Marie-Laure Murat (Lab Manager, Sarco, France), Virginie Moine-Ledoux (Research Director, Laffort)**

International winemaking practices vary significantly from country to country in terms of juice handling. In Australia, as in many other countries, it is typical to treat the free-run and press fractions of juice separately, but not all winemakers separate a press fraction.

Since press fractions typically have elevated levels of phenolic compounds, a different management strategy is required to achieve similar juice quality to that of free-run fractions. This is the reason, for example, why fruit used in Champagne production is whole-bunch pressed: to minimize phenolic extraction, which would detract from the desired textural structure of the final wine.

Studies on the impacts of various fining treatments on juice have been conducted by many large wine companies, but usually only for internal benefit and to streamline their own specific processing regimes. Typically, phenolic extraction is the key focus of such studies, but recently another chemical of grape origin has become important: glutathione.[1] Glutathione is a grape-derived natural antioxidant, which is superior in action to both ascorbic acid and sulfur dioxide. Its function is as an antioxidant in white wines and juice, ultimately preserving aroma.

In order to gain some understanding of the impact of different typical fining treatments on juice quality, a series of trials was conducted in South Africa and France in 2008 and 2009 on Sauvignon Blanc and other grape varieties containing volatile thiols. The results of these investigations were presented at the 2009 South Africa Society for Enology & Viticulture meeting, and are presented below.

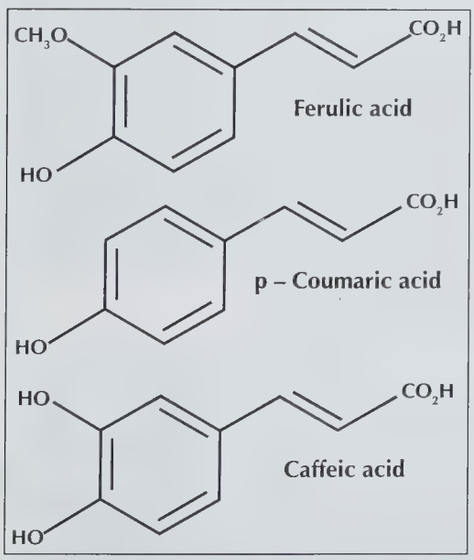

Figure 1. Structures of the phenolic acids quantified in this study.

Juice quality markers

One key group of compounds that is typically analyzed when assessing juice quality is phenolic acids. The assay for these compounds can be as simple as measuring absorbance at 280 nm, which is where phenolic compounds absorb ultraviolet (UV) radiation. The data gained from this measurement are somewhat imprecise, however, so in this study High Performance Liquid Chromatography (HPLC) with UV detection methodology was used.

The phenolic acids measured are illustrated in Figure 1. These phenolic compounds are of interest to winemakers for three main reasons: they can contribute to a sensation of tactile coarseness in wine; they can be metabolized by some organisms to generate volatile phenols, which detract from wine aromatic quality;[2] and they can be oxidized to produce pinking.

Glutathione (GSH) is a relatively newly discovered juice quality marker, and was measured by HPLC with fluorescence detection. It is a tripeptide with a sulfur functionality, and for this reason it, along with other sulfur-containing compounds like cysteine and N-acetyl cysteine (Figure 2), is able to act as an antioxidant. Since the thiol group can be oxidized, the molecule is capable of absorbing oxygen, which is an informal definition of an antioxidant.

As an adjunct to this study, isobutylmethoxypyrazine (IBMP) levels were measured by stir bar sorptive extraction and gas chromatography-mass spectrometry. IBMP is found in some grape cultivars (notably the Sauvignons) and is

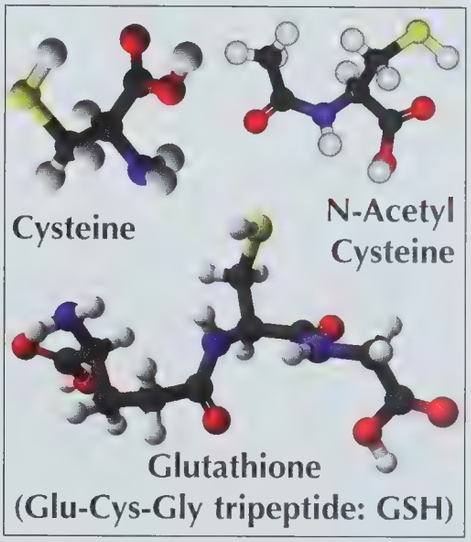

Figure 2. Structures of redox-active molecules found in juice: cysteine, N-acetyl cysteine and the tripeptide glutathione.

Table I: Juice parameters for Case Study 1

	Free-Run	Press Fraction
Potential alcohol (% vol.)	12.60	12.60
pH	3.19	3.47
Total acidity (g/L tartaric acid)	8.12	6.43
Malic acid (g/L)	3.24	3.06
Tartaric acid (g/L)	4.83	4.26
YAN (mg/L)	320	360
SO_2 L (mg/L)	35	34
SO_2 T (mg/L)	63	71

inversely proportional to the level of fruit ripeness and exposure of the fruit to sunlight during ripening. It is responsible for the capsicum ("green pepper") character sometimes found in wine made from these grapes. IBMP is thus a *de facto* measure of juice quality, and was included in this study.

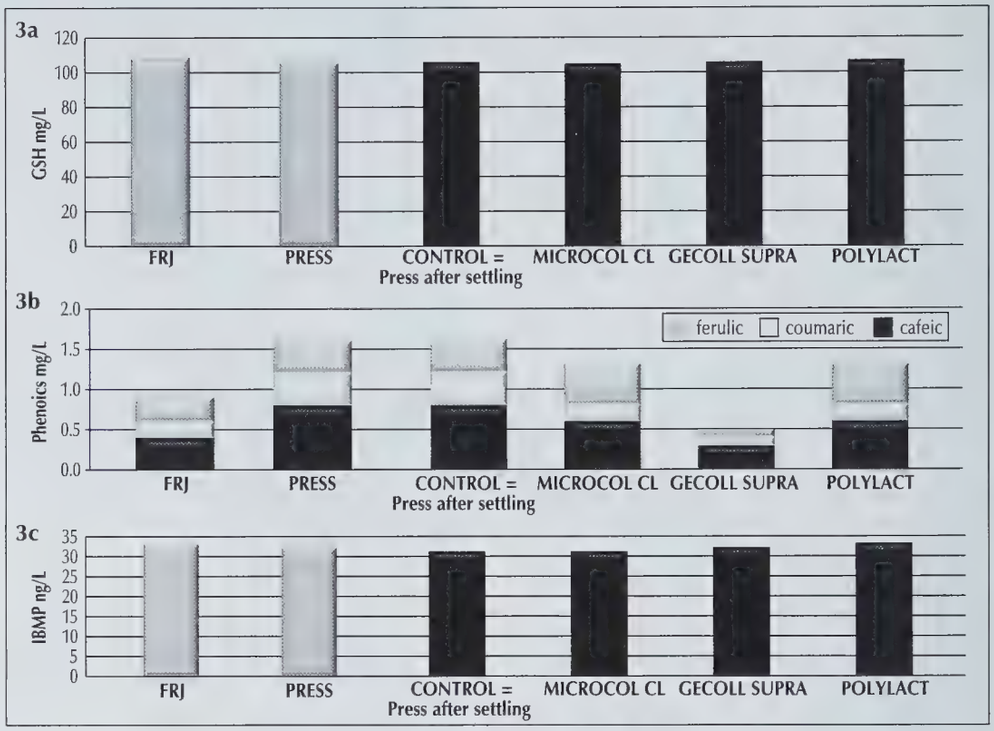

Figure 3. Case study 1 data:
(a) Glutathione content of free-run juice (FRJ) and press fractions (PRESS, left), and residual glutathione content of press fraction after treatment with indicated fining agents (right).
(b) Phenolic acid content of free-run juice (FRJ) and press fractions (PRESS, left), and residual juice phenolic acid content of press fraction after treatment with indicated fining agents (right).
(c) IBMP content of free-run juice (FRJ) and press fractions (PRESS, left), and residual juice IBMP content of press fraction after treatment with indicated fining agents (right).

Case Studies

Case Study 1:
Durbanville, South Africa
Reductive handling of all fractions

Sauvignon Blanc grapes were hand harvested and the fruit sprayed with 5% SO_2 solution. Pectolytic enzyme was added; fruit chilled to 10°C; destemmed and crushed. Free-run juice had 1 hour skin contact under nitrogen gas (N_2) and then cold-settled under N_2 for 24 hours.

The press fraction received 12 hours skin contact under N_2, then pressed and settled for 24 hours under N_2.

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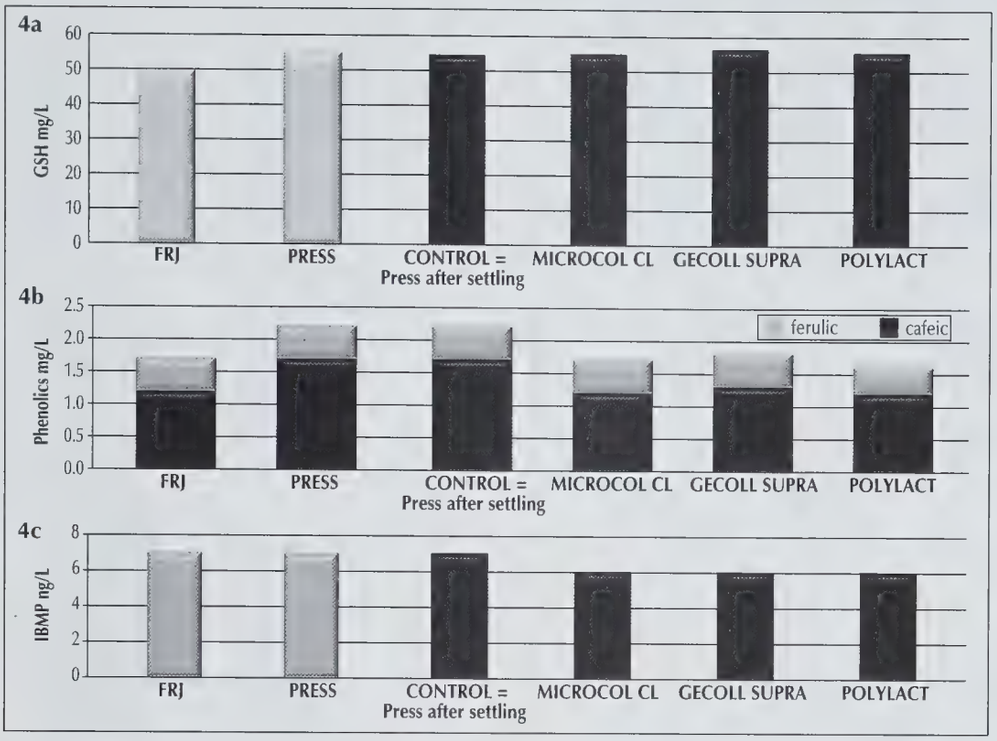


Figure 4. Case study 2 data:
(a) Glutathione content of free-run juice (FRJ) and press fractions (PRESS, left), and residual glutathione content of press fraction after treatment with indicated fining agents (right).
(b) Phenolic acid content of free-run juice (FRJ) and press fractions (PRESS, left), and residual juice phenolic acid content of press fraction after treatment with indicated fining agents (right).
(c) IBMP content of free-run juice (FRJ) and press fractions (PRESS, left), and residual juice IBMP content of press fraction after treatment with indicated fining agents (right).

Following treatments were applied to the press fraction: bentonite 400 ppm, 40 g/hL (Microcol CL); gelatin 400 ppm, 40 mL/hL (Gecoll Supra), PVPP/casein blend 400 ppm, 40 g/hL (Polylact). Juice chemical parameters are in Table I.

Results — The glutathione content of both free-run and press fractions were identical, and remained undiminished after treatment with the indicated fining agents (Figure 3a). The phenolic acid content of the press fraction was close to double that of the free-run fraction. The gelatin treatment achieved the greatest reduction in phenolic acid content after fining (Figure 3b). IBMP was identical in the two juice fractions, and was unaffected by fining (Figure 3c).

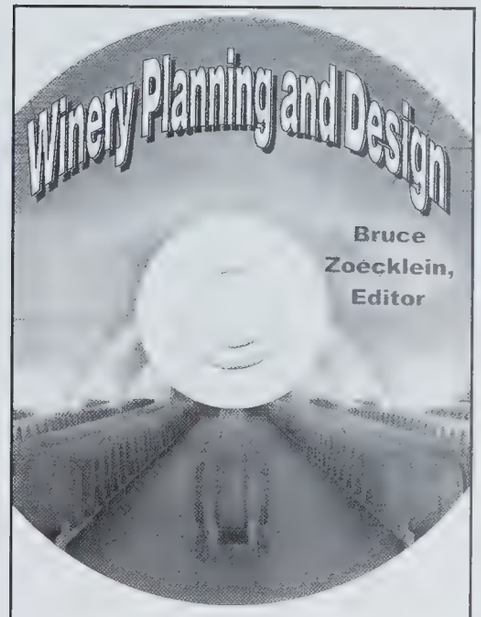
Table II: Juice parameters for Case Study 2

	Free-Run	Press Fraction
Potential alcohol (% vol.)	14.30	14.30
pH	3.35	3.58
Total acidity (g/L tartaric acid)	6.75	5.86
Malic acid (g/L)	2.67	2.61
Tartaric acid (g/L)	5.56	4.98
YAN (mg/L)	320	360
SO_2 L (mg/L)	11	18
SO_2 T (mg/L)	32	52

Discussion — As the juice for this trial was handled reductively, it was not surprising that preservation of glutathione was good. The glutathione content of this juice was very high and is probably linked to the high Yeast Assimilable Nitrogen (YAN) level in the juice, which bodes well for aroma preservation in the finished wine.

The higher phenolic acid content of the press fraction was not unexpected, as more phenolic compounds are liberated from the skins and seeds under increased pressure. The strong impact of the gelatin in fining of the press fraction was also expected, given that the main function of gelatin fining is to remove phenolics.

The bentonite treatment was not expected to remove a large amount of phenolic acids. The PVPP/casein blend



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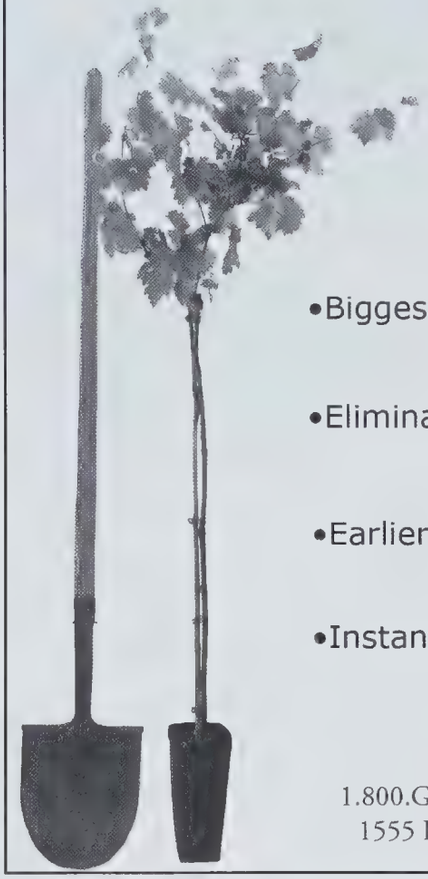
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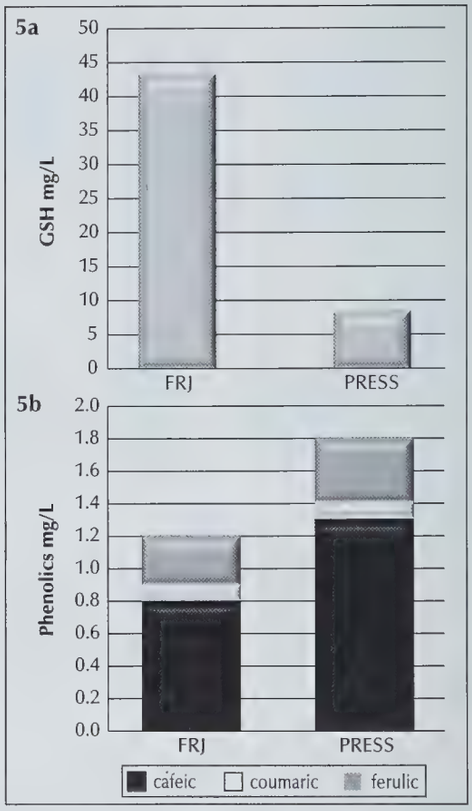

Figure 5: Case study 3 data:
(a) Glutathione (GSH) content of free-run juice (FRJ) and press (PRESS) fractions with oxidative handling in-press. Note the significant loss of GSH with oxidative handling.
(b) Phenolic acid content of free-run juice (FRJ) and press (PRESS) fractions with oxidative handling.

removed about the same amount of phenolic acid as the bentonite, which was somewhat unexpected. IBMP remained unaffected by any fining treatment, which suggests that unripe fruit characters in Sauvignon Blanc cannot be simply removed from the juice by fining; therefore, viticultural control measures need to be considered.

Case Study 2:
Stellenbosch, South Africa
Reductive handling of all fractions

Sauvignon Blanc grapes were hand-harvested and 30 ppm SO_2 added; destemmed and crushed; fruit chilled to 8°C (46°F) with ascorbic acid added (5 g/100 kg) and pectolytic enzyme addition (Lafazym Extract). Free-run juice had 4 hours skin contact under N_2 (in press) then cold-settled under N_2 for 24 to 48 hours.

The press fraction had 4 hours skin contact under N_2 then pressed and set-

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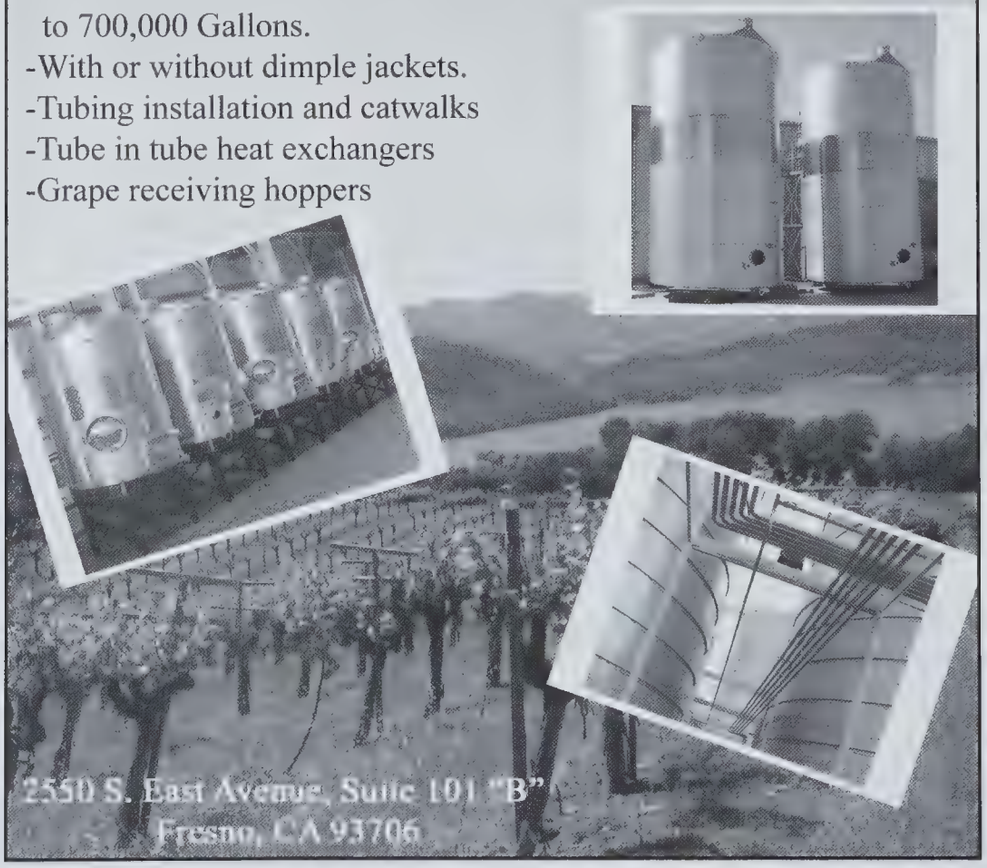
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tled for 24 hours under N_2 with 40 ppm SO_2 added. Following treatments were applied to the press fraction: bentonite 400 ppm (40 g/hL Microcol CL), gelatin 400 ppm (40 mL/hL Gecoll Supra), PVPP/casein blend 400 ppm (40 g/hL Polylact). Juice chemical parameters are in Table II.

Results — Glutathione content of both free-run and press fractions was approximately equivalent, of about half the level of the Case Study-1 juice, and was undiminished after treatment with fining agents (Figure 4a).

The phenolic acid content of the press fraction was about 25 % higher than that of the free-run fraction, and all fining treatments showed approximately equal reductions, with the PVPP/casein product performing the best (Figure 4b). IBMP was equally apportioned between the two juice fractions, and no significant reduction or differences were observed after the fining treatments (Figure 4c).

Discussion — The glutathione concentrations in both juice fractions was less than for the previous trial, yet were still quite high at around 50 ppm, again presumably linked with the high juice YAN value. As with the first trial, glu-

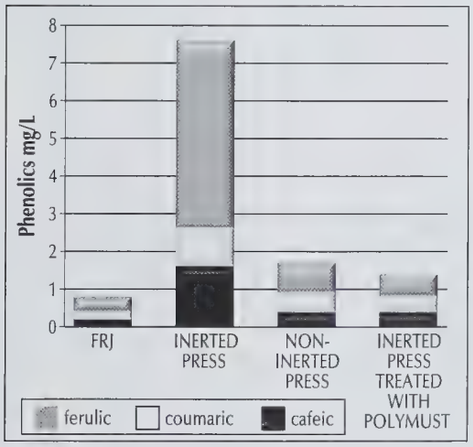
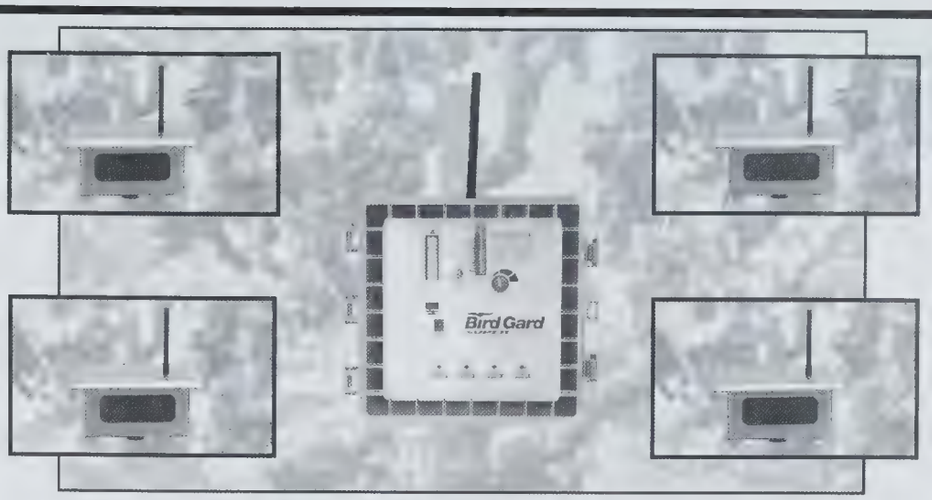


Figure 6: Comparison of phenolic acid content of free-run juice (FRJ), press juice from an inert press (INERTED PRESS), press juice from an oxidatively-handled press (NON INERTED PRESS), and press juice from an inert press treated with Polymust (INERTED PRESS TREATED WITH POLYMUST). Note that the same residual level of phenolic acids can be achieved with both oxidative handling of the juice and treatment with Polymust, except that the oxidative handling destroys much of the glutathione content of the juice (see Figure 5) and thus greatly reduces inherent wine antioxidant capacity.



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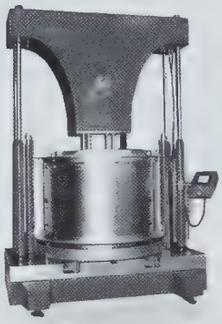

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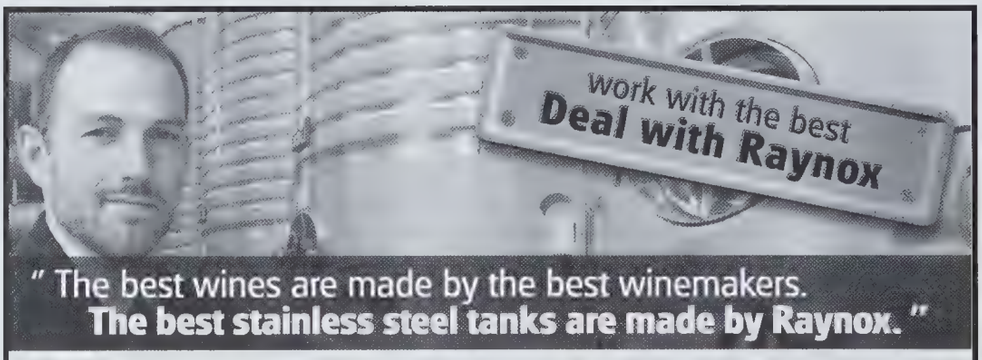

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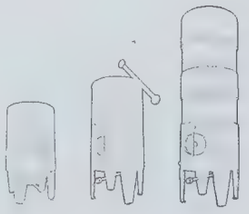

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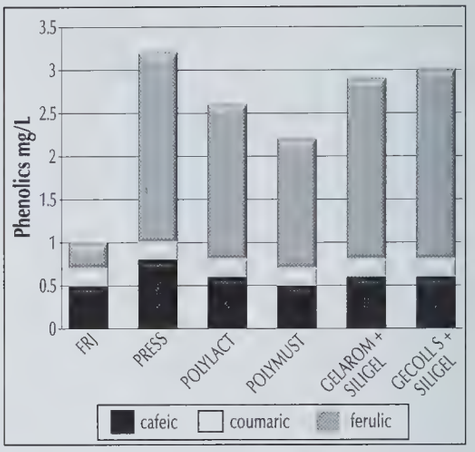

Figure 7: Comparative analysis of reduction in phenolic acid content of free-run and press juice fractions, with various treatments. FRJ = free-run juice; PRESS = press juice; POLYLACT = casein/PVPP blend; POLYMUST = bentonite/PVPP/isinglass blend; GELAROM = gelatin; SILIGEL = silica sol solution; GECOLL S = gelatin.

tathione levels were unaffected by fining, which suggests that juice fining of these types does not impair the natural antioxidant capacity of the juice.

The phenolic acid content of the press fraction was only slightly higher than that of the free-run, perhaps a result of the fairly light pressing (only 60 L press juice yield per ton out of a total yield of 660 L). No coumaric acid was detected in this juice sample.

All fining treatments showed similar effectiveness with respect to removal of phenolics, with marginally better performance observed with PVPP/casein treatment. No significant decrease in IBMP was observed, again suggesting that pyrazine characters cannot be effectively managed through a fining treatment.

Case Study 3: Stellenbosch, South Africa Oxidative handling of press fraction

This trial was conducted at the same winery as Case Study-2, but the press fraction was not protected from oxygen while in press. The theory is that exposing the press fraction juice to oxygen results in oxidation of the more susceptible components of the juice (phenolics), so that, when cleaned up, a juice is somewhat "stabilized." In effect, preliminary oxidation is used as a method of oxidation control, similar to how malolactic fermentation is used to microbiologically stabilize red wines.

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Sauvignon Blanc grapes were hand-harvested and 30 ppm SO_2 added. Fruit was destemmed and crushed, chilled to 8°C (46°F). Free-run juice was handled reductively with N_2 cover, then cold-settled under N_2 for 24 to 48 hours.

The press fraction received 4 hours skin contact and was then pressed with no N_2 protection and cold settled under N_2 for 24 hours. Following treatments were applied to the press fraction: bentonite 400 ppm, (40 g/hL Microcol CL), gelatin 400 ppm (40 mL/hL Gecoll Supra), PVPP/casein blend 400 ppm (40 g/hL Polylact).

Discussion — Oxidative handling of the press juice had a significant impact on the glutathione content (Figure 5a). The press fraction, which was exposed to oxygen in an attempt to oxidize the phenolic acids, suffered a large decrease in glutathione content. This would have a strong impact on the inherent capacity of the wine made from this juice to age well, given that the natural antioxidant capacity of the wine would be severely reduced.

The phenolic acid content of the press fraction was not decreased to equal the free-run fraction (Figure 5b). The biggest impact appeared to be on caffeic acid, which showed the greatest decline. Given that the phenolic acid content was not reduced to the same level as that of the free-run juice fraction, yet at the great expense of the glutathione content, the practice of handling juice oxidatively to control phenolic acid content in juice appears somewhat dubious in terms of resultant potential wine quality.

Case Study 4: Bordeaux, France Comparison between reductive and oxidative handling

To illustrate the relative impacts of these different approaches on the amount of phenolic acids in juice, a comparative trial was done with Sauvignon Blanc in Bordeaux between reductive handling of free-run juice, reductive handling of press fraction, oxidative handling of press fraction, reductive handling of press fraction, and fining with Polymust AF, a combination of bentonite, PVPP, and isinglass (Figure 6).

The reductively-handled free-run and press juice fractions contained the lowest and highest levels of phenolic acids respectively. Oxidative handling of the press fraction showed good reduction in the level of juice phenolic acids, and treatment of the juice with an appropriate fining agent yielded a slightly lower concentration of juice phenolics.

Although oxidative handling of the press fraction juice lowered the phenolic acid content, this was achieved at a very high cost in terms of juice (and therefore wine) quality: attributable to significant loss of glutathione (Figure 5a). This, in turn, has strong ramifications for the ageability of wine made from oxidatively-handled juice, and is perhaps a factor in the "ATA" phenomenon or "untypical ageing off-flavor"[3] which has become a problem in parts of the global wine industry in recent years.[4]

Case Study 5: Bordeaux, France Comparison between fining agents with reductive handling

Given that the importance of glutathione retention in juice is now understood and linked with wine quality and ageability, a similar comparison was conducted between blended proprietary products and gelatin/silica sol applications. This comparison is pertinent given that gelatin is most commonly used for removing phenolics, yet is not an innocuous fining agent.[5]

The trial was conducted using Gros Manseng grapes with reductive handling of all treatments. 600 L/ton of free-run juice yield and the press fraction (60 to 70 L/ton) had 4 hours skin contact under N_2. Additions were: PVPP/casein (Polylact) 40 g/hL (400 ppm); PVPP/bentonite/isinglass (Polymust AF) 40 g/hL (400 ppm); gelatin/silica sol (Gelarom/Siligel) each 20 mL/hL (200 ppm); and gelatin/silica sol (Gecoll Supra/Siligel) each 20 mL/hL (200ppm) (see Figure 7).

In this trial, the greatest reduction in phenolic acid content was after

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treatment with Polymust AF, followed by Polylact, and then the two co-fined gelatin treatments. Comparing these results with those obtained from the preceding trials suggests that different juices respond differently to different fining agents; it is a matter of trial and error to find the most appropriate treatment for a given juice. In time, this could presumably be built up into a historical fining program for a given source of fruit to ensure the best and most consistent results.

Summary

While there are no "right" or "wrong" approaches to juice handling, there are clearly different processing methods available to winemakers, with different outcomes in terms of juice and, ultimately, wine quality.

Given the large impact that glutathione has on juice and wine quality, it is pertinent to remember that oxidative handling, while capable of reducing juice phenolic load, is also highly destructive to this valuable antioxidant. When oxidative handling methods are employed, or to maximize juice antioxidant capacity overall, it would appear prudent that glutathione levels be supplemented.

Glutathione management for increased wine quality is the subject of "Maximizing aroma preservation in white and rose wines," in this ***PWV***. ■

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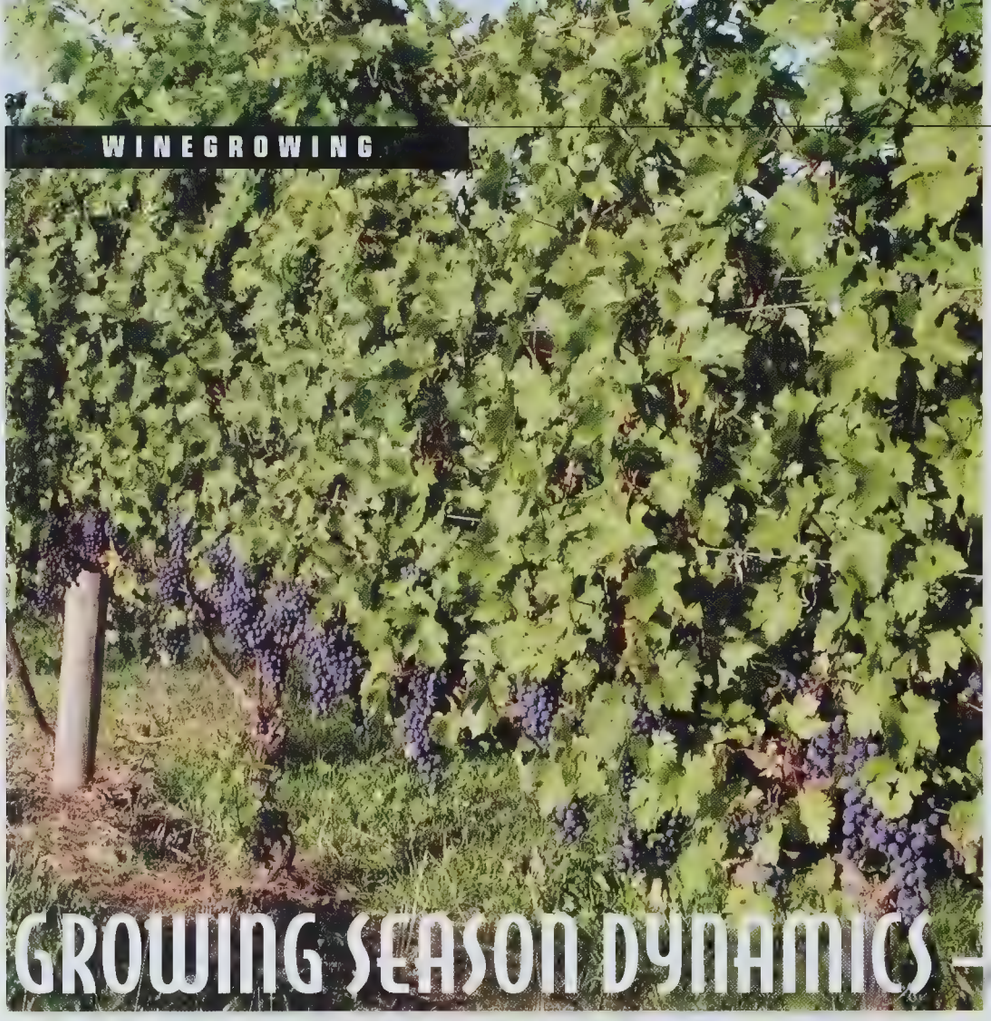

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GROWING SEASON DYNAMICS – VINE BALANCE IMPACT ON METHOXYPYRAZINES

BY Alan N. Lakso and Gavin L. Sacks, Cornell University, New York State Agricultural Experiment Station, Geneva, NY
Corresponding author email: anl2@cornell.edu

Vine balance, often discussed and felt to be a key goal of grapegrowing, refers to the relative balance of vegetative to reproductive growth. The term crop load is conceptually similar, but is more restricted to the balance of vine capacity or supply to crop demand while not directly considering vegetative demands.

The effects of vine balance or crop load on wine quality are frequently discussed in the literature and tasting room. While there is little debate that there is an upper limit to how much fruit a vine can mature before wine quality suffers, there is also increasing evidence that wine quality is diminished when grapes are obtained from vines that are undercropped. In other words, low quality wines are expected from vines that are greatly out of balance, either overcropped or excessively under-cropped.

Vine balance and crop load are described in various ways that are discussed in excellent reviews by P. Dry, and E. Archer and J.J. Hunter.[2,7] Here, we will primarily emphasize a few points on our current approaches, focusing on the seasonal dynamics of vine carbohydrate supply in relation to crop demand, and on the relation of vine balance to winegrape-derived aroma compounds.

Vine "capacity" was defined by A.J. Winkler as the total growth of the vine and crop; the total dry matter production of a vine.[15] This is a function of 1) seasonal sunlight intercepted by a vine (varies with leaf area, canopy display, and climate), 2) conversion of the sunlight energy to dry matter (initially sugars from photosynthesis), and 3) the use of some sugars burned for the energy to build vine components.

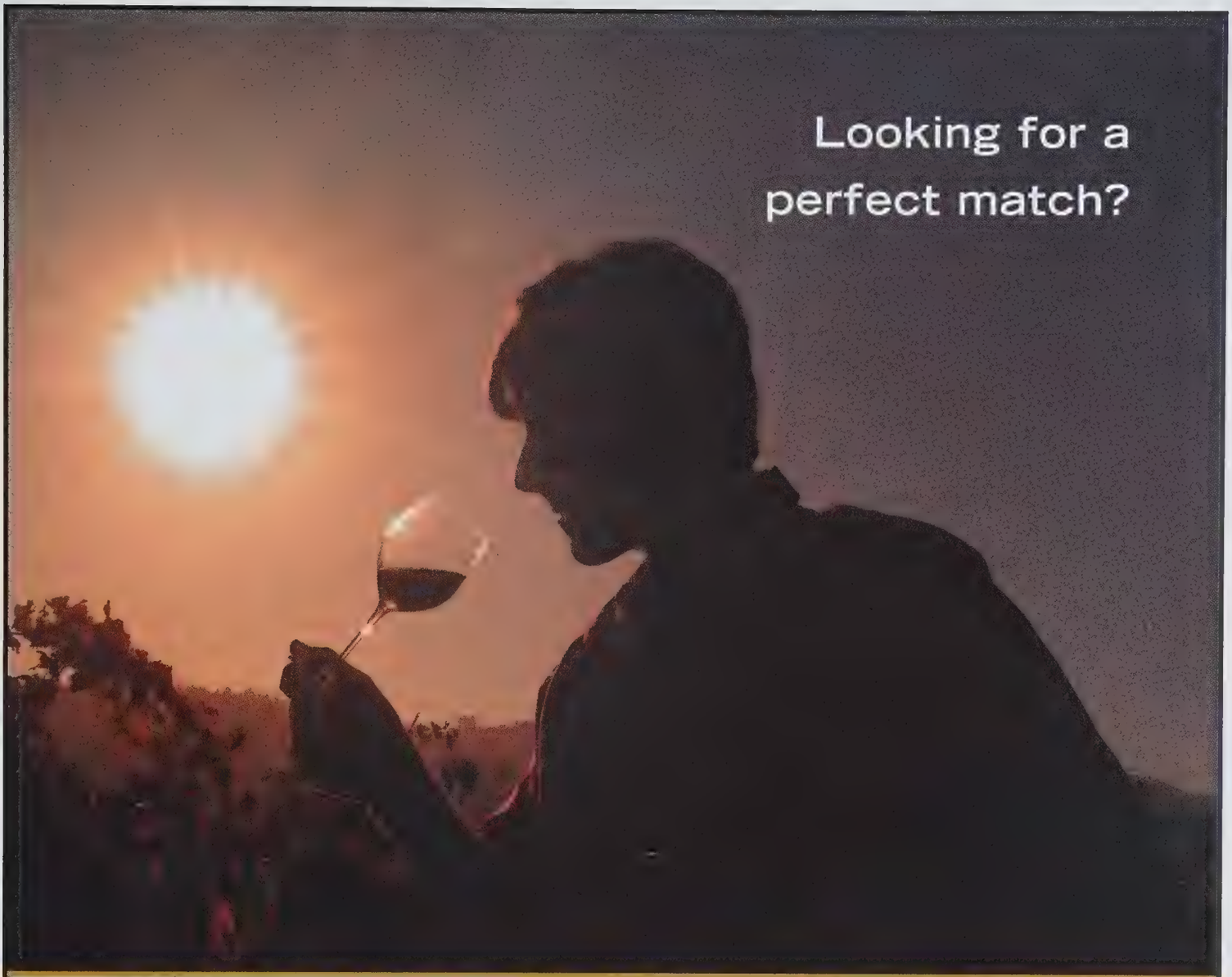
Without sacrificing entire vines, it is not easy to measure vine capacity in the vineyard. Instead, several indirect measures have been developed to estimate vine capacity.

Winter pruning weight is commonly used as an indirect estimate of sunlight interception and thus vine capacity, as it is generally related to vine size late in the season. However, these relationships do not always hold as stresses during the season may give more or less vine growth and reduce leaf function. Additionally, winter pruning weights do not account for shoot growth removed by summer hedging or shoot thinning.

For a given pruning weight the actual vine sunlight interception will depend on spacing, training system, canopy display, and uniformity of trellis fill. For example, divided canopies such as the Lyre system might have similar leaf areas and pruning weights to undivided canopies, but considerably more light interception.

Additionally, the pruning weight to light interception relationship is not linear; changes in pruning weight at low pruning weights will have greater effects than at high pruning weights where additional growth may primarily create more shade rather than increased light interception. Finally, there is only one value given per year, thus any seasonal dynamics are ignored.

Actual leaf area attained during the season is a more valid estimate of vine light interception than pruning weight, and thus the leaf area is expected to be a better metric of vine capacity than pruning weight. It is assumed that exposed leaf area reflects light interception, but in the vineyard it is diffi-



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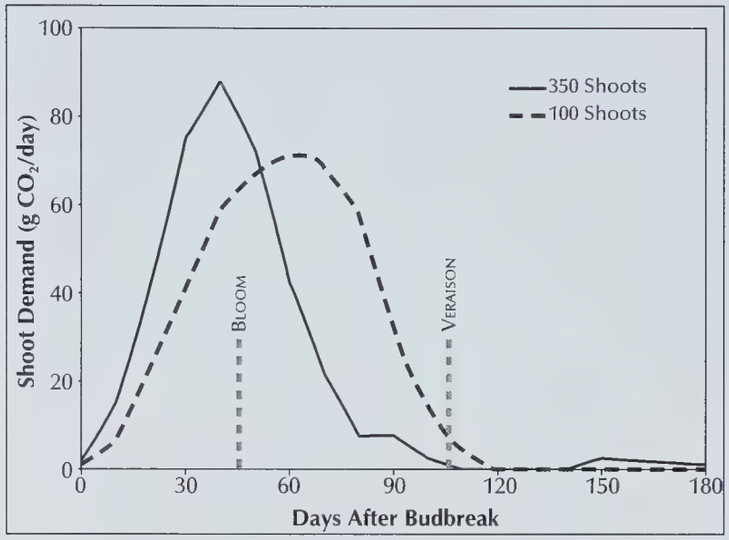

Figure 1. VitiSim simulations of the seasonal carbon demand for shoot growth carbon demand by growing shoots on Concord vines with 100 shoots or 350 shoots per vine and long-term Geneva, NY weather. Note the shift in peak demand.

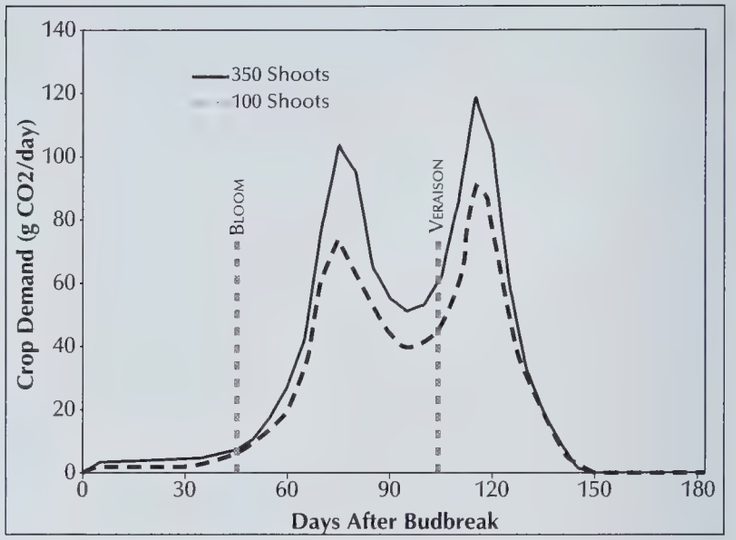

Figure 2. VitiSim simulations of the carbon demand for crop growth of Concord vines with 100 shoots or 350 shoots per vine and long-term Geneva, NY weather.

cult to estimate the exposed leaf area (how much exposure is "exposed"?) and average leaf function due to the complexity of the grape canopy.

Alain Carbonneau developed a practical method in 1995 to estimate vine capacity based on the surface area of varying trellis systems.[4] However, this approach is limited by its assumptions of uniform photosynthetic functionality across the exposed canopy.

In practice, most grapegrowers and viticulturalists discuss "crop load," i.e. the ratio of vine capacity to the demand of the crop, rather than "vine balance."

Measuring crop load requires estimations of both vine capacity and crop demand. "Yield/pruning weight" or "leaf area/g of fruit" address this balance and are useful expressions for estimating crop load. However, they are limited for the aforementioned reasons and do not address seasonal dynamics.

Integrating the many complex processes in a dynamic environment requires dynamic models. Sunlight energy absorption, carbon production and utilization are the best-understood processes, and they have been successfully modeled in many plants. The lead author has developed a simplified carbon balance model to evaluate the seasonal dynamics of the carbon component of vine capacity and demand for carbon.[8,9,10]

Seasonal dynamics of vine balance and crop load

A simplified dynamic carbon balance model, developed initially for

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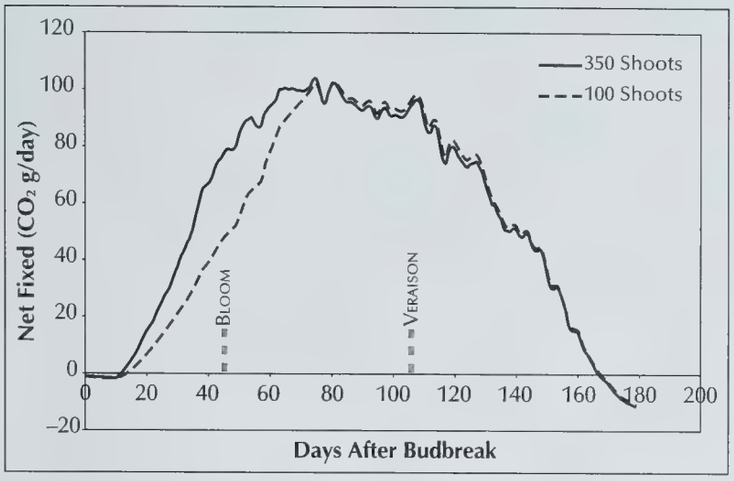

Figure 3. VitiSim simulations of the canopy net CO_2 fixation of Concord vines with 100 shoots or 350 shoots/vine (minimally-pruned) and long-term Geneva, NY weather.

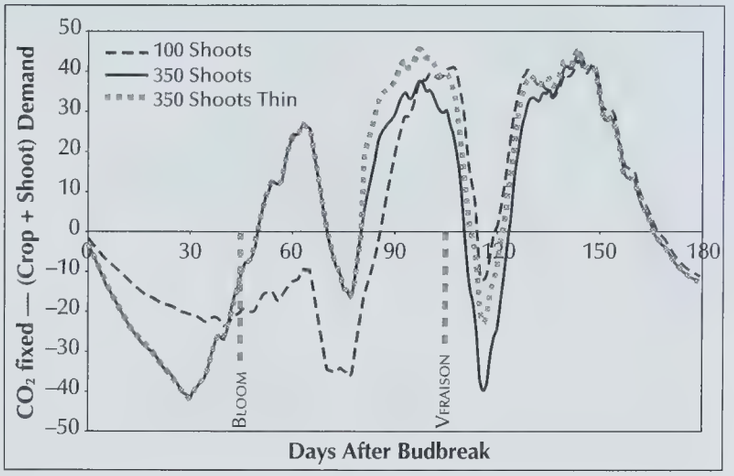

Figure 4. VitiSim simulations of the balance of canopy net CO_2 fixation minus the combined demand of crop and shoot growth of Concord vines with 100 shoots or 350 shoots per vine (minimally-pruned). The dashed line is the simulation of partial crop thinning of minimally-pruned vines.

apple trees, was adapted for grapevines using STELLA®, an easy-to-use auto-programming software. The model (VitiSim) uses a daily time step to simulate seasonal leaf area development, vine light interception, canopy photosynthesis, canopy respiration, total dry matter accumulation, and dry matter distribution to competing vine organs (leaves, roots, fruit, etc.).

From this data we can: a) develop seasonal curves of the growth, vine

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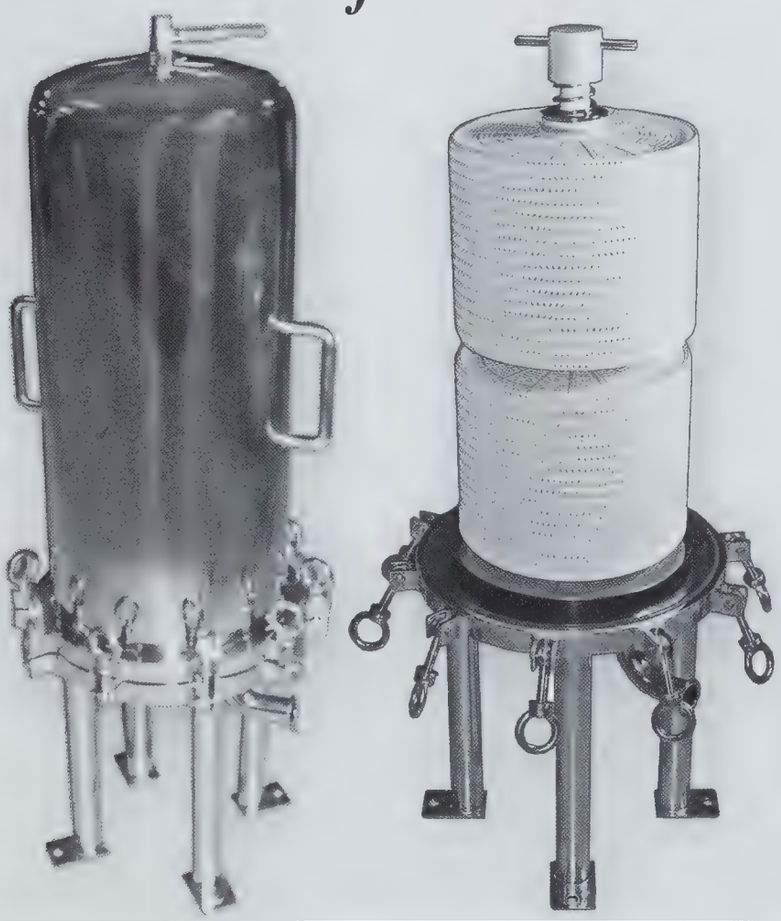

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Dormant Cabernet Franc vines in New York, showing somewhat stronger vigor than needed for trellis fill.

Dormant Syrah vines, Ridge Vineyards (Geyserville, CA), showing low-to-moderate shoot vigor.

capacity, and demands of various organs and estimate balances between their supplies and demands; b) evaluate the effects of daily weather or long-term climate patterns and different stress and cultural factors on these patterns; and c) try to determine if and when critical periods of carbon supply and demand

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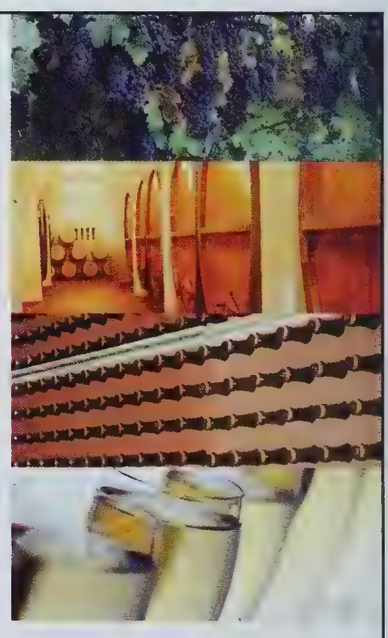

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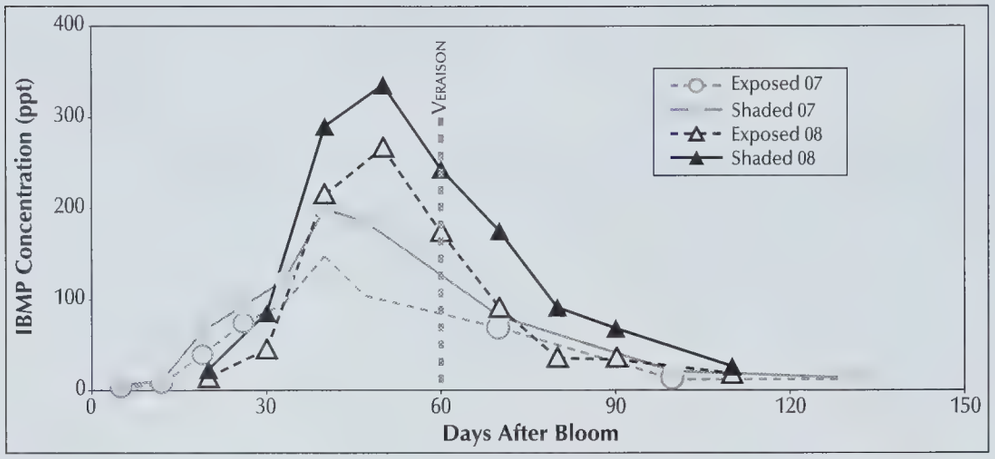

Figure 5. Seasonal pattern of berry IBMP concentration in exposed and shaded clusters of Cabernet Franc in New York.

occur, especially in relation to fruit development and ripening.

Seasonal demand dynamics

In mature vines, the vast majority of net seasonal dry matter assimilated goes into current growth (leaves, shoot stems, and crop). In this example, we present model simulations of healthy, unstressed, heavily-cropped Concord grapevines (spaced 8 x 9 feet) with industry standard 100 shoots per vine (yield of about 9 tons per acre) compared to minimally-pruned vines with 350 shoots per vine (yield of about 12 tons per acre).

Seasonal patterns of supply and demand are distinct. The carbon demand of growing shoots show a single peak around or after bloom. This peak demand occurs earlier in vines with higher node numbers and later in vines with fewer shoots that grow longer into the season (Figure 1). The demand pattern for the crop is a double peak, with a peak a few weeks after bloom during berry cell division, followed by a decline during the lag period (Figure 2).

After veraison, the second peak of demand occurs very rapidly, and then declines with ripening. Shoot numbers affect the timing of peak demand. However, different crop levels affect the amount, but not the timing, of crop demand in our simulation. Root growth patterns have been reported to be variable, but likely reflect a weak sink throughout the growing season.[6]

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Seasonal carbon supply and supply/demand balances

The seasonal pattern of supply is relatively simple, peaking between bloom and veraison. Supply is affected primarily by total light interception. Since light interception depends on leaf area, more shoots will lead to more rapid canopy development and an earlier peak in canopy photosynthesis (Figure 3).

The effects of pruning level on the individual demand and supply curves do not appear very striking. However, when the combined demand of the crop and the shoot canopy are subtracted from the net CO_2 supply available from canopy photosynthesis (Figure 4), there are several differences observed in the balance. Compared to the 100-shoot vine, the minimally-pruned vine requires more reserves initially due to the greater number of growing shoots.

However, minimally-pruned vines also have a more rapid canopy completion and earlier cessation of shoot growth, resulting in an earlier decline in carbon demand by shoots. This results in a more positive carbon balance than lower-shoot number vines in the immediate post-bloom period critical for fruit set, flower bud develop-

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ment, and early root growth. Conversely, post-veraison, the minimally-pruned vine has a strong carbon deficit as the supply is similar but the crop demand is much higher than the lower shoot number vine.

These results may explain why Cornell researchers have found stable high yields over many years with minimally-pruned vines, if drought stresses are limited, yet these vines struggle to reach acceptable sugar levels in the crop.

A practical response has been developed by our colleagues, the late Bob Pool and currently Terry Bates, by using high node numbers, then mechanically thinning the crop at 75 to 80 days after budbreak (about 30 days after bloom) to reestablish the vine crop load (dashed line in Figure 4). It may also explain why we have not found any reduction in fine root growth, and found slightly earlier root growth with minimally-pruned vines, even with 20% to 25% higher crop levels.[6]

A low-vigor Viognier vine at Hawley Wines (Dry Creek Valley, CA) can also have good balance, though the limited shoot vigor limits vine capacity and appropriate yield.

Although Concord vines may not represent the shoot numbers and crop in wine grape systems, we believe the general patterns and the effects of pruning level shown will be similar in most species and varieties. Hopefully a better understanding of the seasonal dynamics of carbon balance and vine growth will help improve our understanding of vine balance.

Vine growth, balance, and flavors

Ultimately, we wish to understand the effects of vine balance on compounds relevant to wine flavor. New York State winemakers occasionally observe excessive green characters in wines produced from red Bordeaux varieties (Cabernet Franc), especially during wet or cool growing seasons.

The presence of herbaceous aromas in Bordeaux-cultivar wines has been at least partially attributed to a class of compounds called methoxypyrazines (MPs), and in particular isobutylmethoxypyrazine (IBMP).

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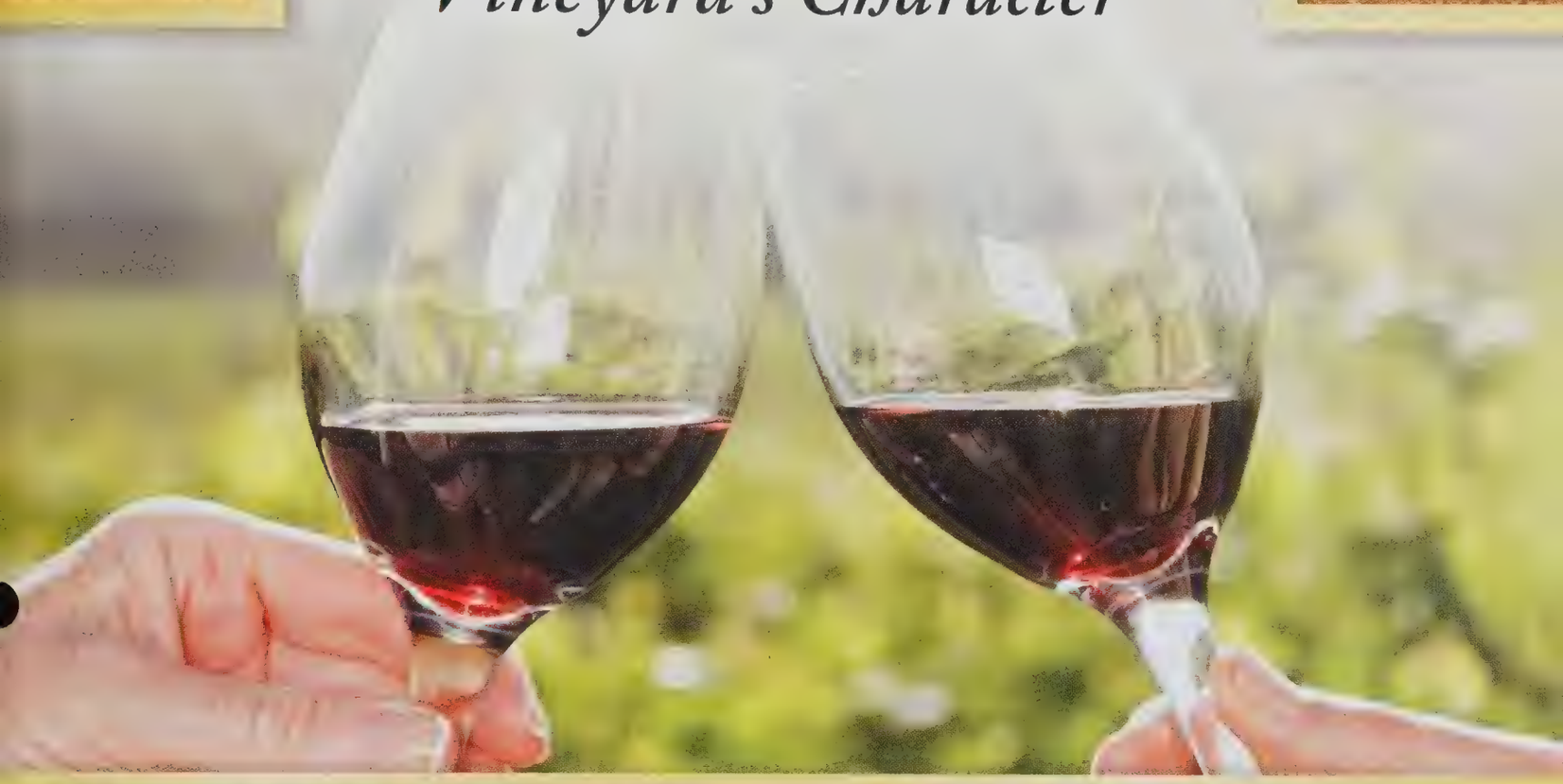

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Several reports have mentioned that higher water availability and/or vine growth are correlated with higher MP levels.[12,14] However, vine growth is also associated with cluster shading, which, in turn, is correlated with increased MP levels. In our labs, we have attempted to decouple the impact of cluster exposure from vine growth.

Experiments on vigor and IBMP in Cabernet Franc

Investigations of the impact of vine vigor on fruit composition are often confounded because changes in vine vigor generally influence cluster light environment. To decouple the effects of cluster exposure and vigor on MP accumulation/degradation patterns, we conducted two separate experiments in the 2007 and 2008 growing seasons to determine seasonal patterns of IBMP in Cabernet Franc in the Finger Lakes region of New York state.

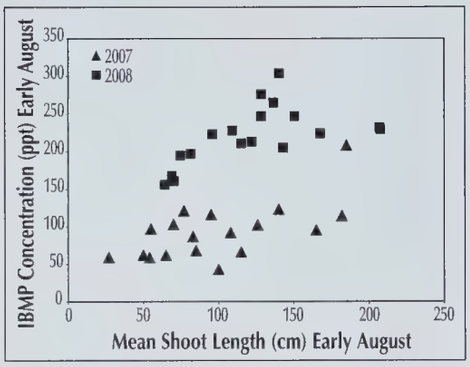

Figure 6. Relationship of pre-veraison maximum berry IBMP and mean vine shoot length during the main period of IBMP synthesis.

In the first set of experiments, the impact of varying light exposure was investigated by comparing MP levels between exposed and shaded clusters within the same vines.[13] Seasonal IBMP concentrations in fruit showed the same pattern in 2007 and 2008, with the majority of accumulation occurring between 20 to 50 days after bloom (Figure 5). Higher maximum levels of IBMP were observed in 2008 (a mild year with a wet period and active shoot growth during IBMP accumulation) than in 2007 (a dry, hot year of reduced shoot growth just prior to the IBMP synthesis).

Interestingly, the percent decrease in IBMP at post-veraison time points for both exposed and shaded clusters compared to their pre-veraison maxima appears to be similar. Thus, cluster light exposure appears to exert influence on IBMP accumulation pre-veraison, but to have little effect on IBMP degradation post-veraison.

In the second set of experiments, cluster light environment was kept constant for shoots on a cane on one side of each vine. Differences in shoot vigor were created by retaining variable shoot numbers on the other side of each vine.

The impact of varying vigor on MP concentrations in berries was investigated by measuring IBMP levels only

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on well-exposed clusters to avoid confounding changes caused by cluster microclimate. A positive correlation between IBMP levels was observed at the pre-veraison maximum and mean vine shoot growth (Figure 6).

Therefore, IBMP accumulation appears to be correlated with vine growth independent of changes caused by light environment. This observation is consistent with other evidence from the literature.

Conditions that lead to more vigorous growth, especially higher water status or lower croploads, are positively correlated with IBMP concentrations at harvest.[5,11,14]

Minimally-pruned vines are reported to have up to 8-fold lower concentrations of IBMP during the season than normally-pruned vines with lower bud numbers,[1] with the former expected to have lower vigor and earlier shoot termination. In our study, the shoots of minimally-pruned vines essentially all terminated prior to the IBMP synthesis period.

In a study on the effects of crop load on fruit chemistry, D.M. Chapman found that 1) pruning heavily to low bud numbers reduced crop but led to

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Cabernet Franc cluster zone in moderately vigorous vine (New York). Good vine balance reduces lateral growth and makes it easier to properly expose fruit.

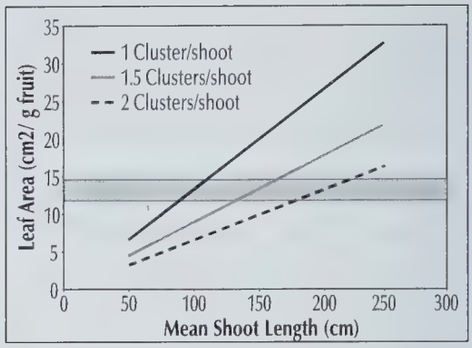

Figure 7. Calculation of Cabernet Franc leaf area per fruit for shoots of different lengths with 1, 1.5, or 2 clusters (approximating yields of 7, 10, and 14 tons per ha) based on experimental data on shoots and cluster weights. Assumes adequate leaf exposure. Gray bar indicates adequate LA/g fruit of about 10 to 12 cm².

higher IBMP, and 2) thinning at veraison to a range of smaller crop loads had essentially no effect on IBMP.[5] Although growth data was not presented, it is likely that heavier pruning led to increased vigor.

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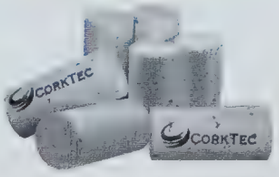

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In summary, the time period between 20 to 50 days post-bloom appears to be critical in determining maximum IBMP concentrations in winegrapes in our studies. Greater cluster shading and vine growth are independently correlated with increased IBMP accumulation during this time.

In our studies, vine growth has a quantitatively comparable or greater impact than cluster light environment on IBMP accumulation. A key outcome from these observations is that IBMP levels in vigorous vines cannot be controlled by leaf removal alone.

What is an appropriate vine balance?

To achieve desired vine balance preveraison, the vine should:

1) develop adequate leaf area and canopy to be able to appropriately ripen a given crop and to support adequate vine development and reserves of roots, reserves, and bud development for the next year;
2) but not have excessive vegetative vigor leading to problems associated with excessive canopy growth and density.

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The negative impacts of inadequate leaf area–to–fruit ratios (Statement-1) are well recognized: the resulting fruit is generally immature, with lower Brix and anthocyanins, impeded development of roots and starch reserves, and decreased bud fruitfulness in the following season.

Not surprisingly, excessive croploads are generally associated with lower potential wine quality, and consequently maximum allowable yields are regulated in several premium growing regions.

The negative impact of excessive leaf area - to - fruit ratios (Statement-2) is not as well characterized. This condition will result in greater vegetative growth, and in turn, denser canopies and increased cluster shading.

Dense canopies are associated with reduced airflow and greater disease potential, and cluster shading can reduce anthocyanin accumulation, increase IBMP accumulation, and slow malate degradation.

However, our current studies indicate that vegetative growth is also positively correlated with IBMP accumulation even when cluster microclimate is similar. Therefore, vine balance may be critical for ensuring optimal flavor of Bordeaux varieties independent of cluster microclimate.

Over several years of study, Dr. Lakso's lab has determined the relationship of shoot length and leaf area. Accepting the common value that 12 to 15 cm^2 of exposed leaf area is necessary to fully ripen a gram of fruit without delaying harvest, it is possible to calculate the shoot length necessary to ripen a Cabernet Franc crop of 1, 1.5, or 2 clusters per shoot (3.5 to 4, 4 to 4.5, and 6 to 6.5 tons per acre, respectively) assuming typical 2- to 3-inch shoot spacing and 125 to 150 g/cluster (Figure 7).

We calculate that shoot lengths of about 100 cm would be adequate to ripen 3.5 to 4 tons per acre, 140 cm to ripen 4 to 4.5 tons/acre, and 180 cm to ripen 6 to 6.5 tons/acre.

A vine with shorter shoot lengths than required for its crop can be considered "overcropped" although extended growing seasons may allow adequate ripening.

Conversely, a vine with too little fruit as a result of aggressive crop control (heavy pruning) may undergo vigorous shoot growth pre-veraison. Greater shoot growth is correlated with greater IBMP accumulation (Figure 6), and thus may help explain why low crop loads are reported to result in higher IBMP at harvest.[5]

Again, our current data indicate that the correlation between IBMP accumulation and shoot growth is **independent** of cluster exposure. Vines with excessive shoot growth would, in this case, be considered "undercropped," as these conditions are correlated with higher IBMP.

Furthermore, shoots that continue to grow late into the season will typically have longer final shoot lengths. In our experiments, shoots that grew longer than150 cm (4.5 feet) terminated growth before 20 days post-bloom. We note that 20 days post bloom also corresponds to the start of the majority of IBMP accumulation.

In our future studies, we hope to elucidate which biological processes regulate late season shoot growth, and if they are also related to IBMP synthesis.

Interestingly, several international premium winegrape growers have

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commented to the authors that 150 cm (4.5 feet) long shoots are optimal for best-quality grape production of Bordeaux-type cultivars.

Based on our model, shoots must be at least this long to provide adequate capacity for good development of the crop, roots, and perennial reserves. Shoots longer than this target length are expected to result in excessively dense canopies and demand expensive canopy management practices (shoot topping). Additionally, undesirable changes to fruit secondary metabolites (greater IBMP) have also been observed in these vines.

Reaching this 150 cm shoot length target is not always easy. With a low-potential site, organic matter, nutrients, and water can be added incrementally to help vine growth reach the desired balance. Many growers in arid zones effectively utilize some form of deficit irrigation in the bloom-to-veraison period to regulate shoot growth and reach the desired canopy characteristics.

With high-potential sites, especially in wetter climates or years, preventing excessive growth is more challenging. In humid climates, it may be advantageous to move to higher bud counts to develop a full canopy quickly and reduce final shoot length.

Following fruit set and early berry development, cluster-thinning can be used to achieve an appropriate crop level. This is analogous to the procedures used in the minimal pruning example given early.

It should be noted that our work refers to Cabernet Franc, and more generally to red Bordeaux cultivars. The impact of vine balance on flavor compounds of relevance to whites and other red cultivars (Pinot Noir) may be different. Furthermore, the (bio-) chemical and physiological mechanisms by which vegetative growth is related to production of secondary metabolites such as MPs are still unclear, and deserve further study.

Summary

- Vine balance implies that vines are neither undercropped nor overcropped.
- While overcropped vines are well acknowledged to yield lower wine potential, undercropped vines may also have reduced winegrape qualities.
- We have observed that methoxypyrazine accumulation is correlated with shoot growth in Cabernet Franc.
- Vine balance is not static over the growing season as is implied by simplified crop load indices.
- Dynamic carbon balance modeling can be used to understand the needs of a grapevine throughout the growing season.
- The relationship between vine growth and winegrape flavor development is an important area for future research. ■

Acknowledgments

We would like to thank the following for their contributions to the research: Imelda Ryona, Diego Intrigliolo, Bruce Pan, Richard Piccioni, Richard Dunst, and Michelle Rose.

Continued on page 73

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FREE RUN

Achieving balance in wine country

BY Jim Law

Several American wine regions are experiencing fairly contentious state and local zoning debates. In Virginia, my own Fauquier County has been no exception. At the most recent public hearing on the subject I was the clear minority of one winery in speaking out in favor of a county zoning ordinance that would curb some winery events.

Neighboring winery colleagues have expressed disappointment in my remarks and politely asked that I consider muting my opposition to an otherwise unified effort. This is a fair request. I have to admit that there are times when I fear that I have become the crusty curmudgeon who rains on the party.

Ultimately I could not ignore the fact that my neighbors' wines and marketing activities have a very direct impact on my business in two ways.

1. Dangling Qualifier

Wines are categorized by region. Like it or not, we are all lumped in together. How many times have I heard what I call the "dangling qualifier" from customers tasting my wines: "This is good ... for a Virginia wine." My neighbors' wines thus have an impact on my winery's reputation and potential price point.

In Australia, Yellow Tail has been the bane of artisan high-end producers trying to sell wine in the U.S. market.

French wine regions have also felt the impact. In the 1970s, Beaujolais Nouveau was heavily promoted. They certainly moved the juice, but this cash flow wine became a category killer. Small, traditional terroir-focused producers can now scarcely give their wines away. It is frightening to talk to these Beaujolais winegrowers. Wines from coveted terroirs in Morgon, Chenas, or Moulin-à-Vent no longer interest the wine-consuming public, who can only associate the term Beaujolais with nouveau.

On more than one occasion, I have heard Virginia wineries [dismissed to as simply] entertainment wineries. This comes from prestigious wine retailers and sommeliers in the Washington, D.C. area, potentially our best market. They carry few Virginia wines.

The majority of Virginia wineries sell most of their production at the tasting room or at festivals. This is only possible because these wineries are within a day trip of Washington, D.C.

When there were just a handful of wineries in Virginia, one only had to hang a shingle and open the tasting room doors. There were enough customers around for a small winery to sell a modest production.

Today, however, there are close to 100 wineries within a reasonable drive of Washington, D.C. Special events, rather than improved wine quality, seem to be the trend for attracting customers.

My fear is that, as our industry becomes more entertainment-focused, wine quality will take a back seat to the front of the house. Virginia is on the cusp of putting all the pieces together to make wines of exceptional quality. This requires risk, time, expense, and intellectual focus.

On the other hand, market-driven wines are by definition safe, serviceable, soulless, and cash flow-friendly. It does not have to be this way, but it usually is.

2. Pendulum Swing (from darling to devil)

Ten years ago most residents viewed wineries and vineyards as benign and welcome neighbors. Not only were vineyards romantic, but they also enhanced property values (if one believed real estate brochures). This euphoric period is history now, primarily due to community concerns over amplified music, buses, late evening events, and DUI. Entrepreneurial impatience has replaced visionary winegrowing.

Politically-savvy wineries successfully lobbied the Virginia Legislature to include weddings, concerts, and festivals as agricultural activities. These functions now fall under the guise of a recently passed state law that attempts to define normal and customary farm winery marketing activities. This law only makes sense to those who paid for it. To the consternation of some of their neighbors, wineries have taken advantage of their status as farms.

As the growth of entertainment wineries continues, local county governments are being pressured by neighbors to curb activities. The resulting regulatory pendulum swing could eventually impact more traditional cellar door tastings and sales. This would be devastating to the smaller, low-key wineries that depend on these sales for their livelihood.

The desire and need to have events at a new winery is understood. Linden Vineyards attempted to hold events when we first opened. We soon found that we were managing a separate business enterprise that was far removed from winegrowing.

In Virginia, farm wineries are legally able to operate in agriculturally zoned land if they grow the majority of the grapes used to produce their wines. This keeps us honest.

However, when farm wineries begin holding weddings and non-wine-related events on a weekly basis while buying "shiners" (unlabeled bottled wine) from other wineries, the sizzle has become more important than the steak, and we are all in trouble.

Every winegrower's goal is to produce a balanced wine. A balanced marketing program should follow. ■

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GLUTATHIONE

AROMA PRESERVATION in white / rosé wines

BY **Paul K. Bowyer (Technical Manager, Laffort Australia), Marie-Laure Murat (Lab Manager, Sarco, France), Virginie Moine-Ledoux (Research Director, Laffort)**

All winemakers are concerned with quality, to greater or lesser extents and within budget constraints. In white winemaking, appearance of the wine is secondary to the nose of the wine. It is critical that a wine of quality be expressive of both varietal character and *terroir*. For aromatic wines such as Sauvignon Blanc, which typically do not improve with bottle age, saleability relies heavily on freshness and maintenance of the wine's aroma profile.

Wine aroma changes over time. The first aromatic compounds to be lost are those that are most susceptible to oxidation, such as the volatile thiols in Sauvignon Blanc (and other varieties such as Riesling, Colombard, Gros Manseng, Verdelho) including 4MMP, 3MH and, particularly, 3MHA (Figure 1).[1]

Methods of preserving wine aroma include several approaches, from reductive (protective) handling of fruit and juice, to addition of tannin, although all preservation methods have drawbacks. For example, reductive handling requires the use of inert gases, while tannin additions, if done excessively, can alter the palate of the final wine.

Glutathione

A more recent approach to aroma preservation is the use of the protective power of glutathione.[2] Glutathione (GSH) is a plant-derived natural antioxidant, which is superior in action to both ascorbic acid and sulfur dioxide. It has been known for many years that GSH is a more potent antioxidant than ascorbic acid, and that it is thus preferentially consumed ahead of ascorbic acid under oxidative conditions.[3]

It is thought that one function of GSH in plant systems is to maintain ascorbic acid in its reduced form for improved physiological activity.[4] In grapes, GSH accumulates during ripening[5] with levels varying considerably, ranging from 17 to 114 ppm,[6] whereas in yeast, GSH constitutes about 1% of the dry mass.[7,8]

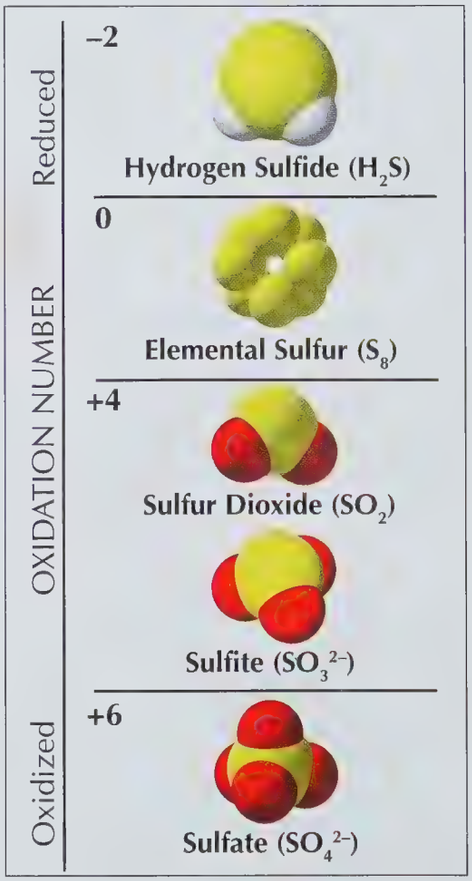

Figure 5: Progression of sulfur through a series of oxidation states, from reduced (H_2S) to elemental sulfur (S_8), then sulfur dioxide (SO_2) and sulfite (SO_3^{2-}), finishing with the (SO_4^{2-}) form.

The glutathione content of wine is known to correlate with the yeast available nitrogen (YAN) content of the juice,[8] for the simple reason that if juice YAN is low then GSH is consumed by the yeast as a nitrogen source.

For example, in Figure 2, when juice YAN is sufficient, the GSH content of juice and finished wine is approximately equal. When juice YAN is less than 100 ppm, very little GSH remains in the corresponding wine. Additionally, yeasts assimilate GSH in the early stages of fermentation and release it in the latter stages, particularly during autolysis (Figure 3), although this is a slow process.

Given the potency of GSH, winemakers can use this compound in winemaking as a natural antioxidant for preservation of wine aromas that are susceptible to oxidation, and concurrently delay the appearance of developed characters. By using the protective power of glutathione, winemakers are now able to preserve wine freshness and prolong consumer appeal in a way that has not previously been possible.

Previously, we have demonstrated the large reduction in GSH levels observed during the oxidative handling of juice, and also that selected fining practices do not remove GSH from juice.[10] Below, we will demonstrate how manipulation of GSH during fer-

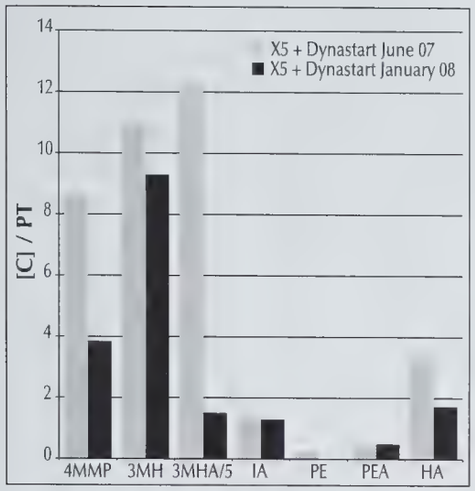

Figure 1: Comparison of aroma profiles of a wine fermented with Zymaflore X5 rehydrated with Dynastart®, analyzed at two time points (June 2007 and January 2008) separated by 7 months with cellaring at 15°C under screwcap. Aroma intensity is expressed as Concentration/Perception Threshold (c)/PT), where a value of ≥1 indicates contribution to wine aroma. 4MMP = 4-methoxymercaptopentanone (broom/boxtree); 3MH = 3-mercaptohexanol (grapefruit); 3MHA = 3-mercaptohexyl acetate (passion fruit); IA = isoamyl acetate (banana); PE = phenyl ethanol (rose); PEA = phenyl ethyl acetate (tea); HA = hexyl acetate (pear).

mentation can increase aroma longevity in aromatic wines.

Antioxidants

Antioxidants behave in a manner similar to electrochemically-active species, because they respond to the potential for oxidation or reduction in their environment. For example, examining a series of chemicals that are thought of as antioxidants (Figure 4), one can see that tannins are more effective antioxidants than SO_2.

In white and rosé wines, no significant amounts of tannin are present, and the next most effective antioxidant in such wines is glutathione. Clearly, maximization of GSH will lead to better wine preservation. The goal of winemakers should thus be to maximize the GSH concentration in these wines.

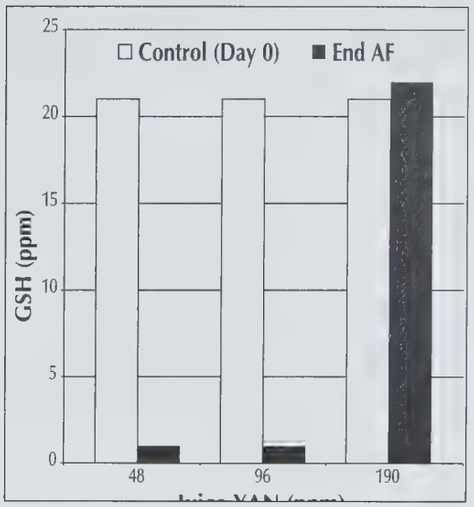

Figure 2: Correlation between juice YAN and subsequent GSH content of wine.

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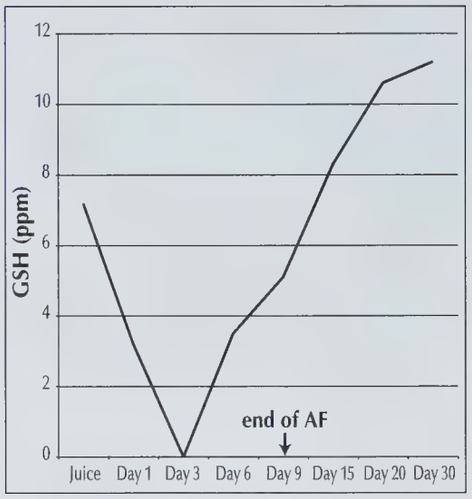

Figure 3: Concentration of GSH during fermentation and lees ageing with sufficient YAN.

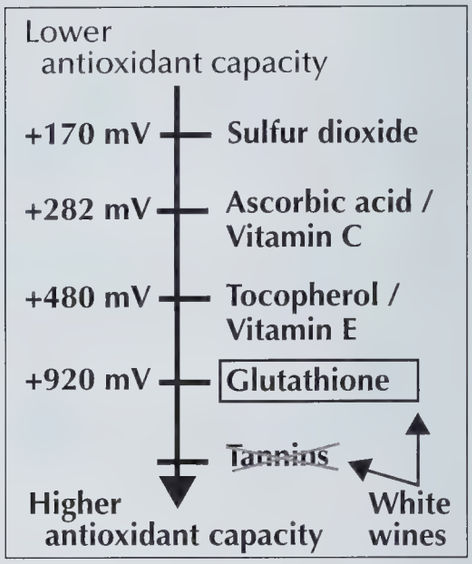

Figure 4: Comparison of reduction potential of various antioxidants.

What makes GSH an effective antioxidant? It is the presence of a thiol group in the molecule. Thiols provide many of the strongest fruity characters found in certain wines (such as Sauvignon Blanc), and these aromas can be susceptible to oxidation precisely because they are good antioxidants, like GSH. The problem is that when they react, as antioxidants, their contribution to wine aroma is lost or altered, hence wine quality deteriorates.

The thiol group (–SH) is a reduced form of sulfur (S). Sulfur is able to react with oxygen to form oxides (as in SO_2), sulfites (SO_3^{2-}) and, ultimately, sulfate (SO_4^{2-}). Since an informal definition of oxidation is "combination with oxygen," the progression of sulfur from –SH to SO_4^{2-} constitutes the behavior of an antioxidant (Figure 5).

With glutathione, the situation can be slightly more complicated in that, for the more chemically-minded, GSH acts as a nucleophile and regenerates hydroquinone and quinone species, which are oxidized forms of phenols (see Figure 6). The end result is typical antioxidant behavior, since the oxidized form of the molecule is reduced to the original phenolic form, with glutathione now bound to the phenolic core to form the "grape reaction product."

Preserving wine aroma

Some simple practical adaptations can be made to preserve the glutathione content of wines. Maintenance of the SO_2 level is essential, remembering that it has both anti-microbial and antioxidant roles. Lees ageing, provided the lees came from a healthy fermentation, are clean and are free of contaminating organisms, can clearly improve wine GSH content, since GSH is released by yeast during the start of autolysis.

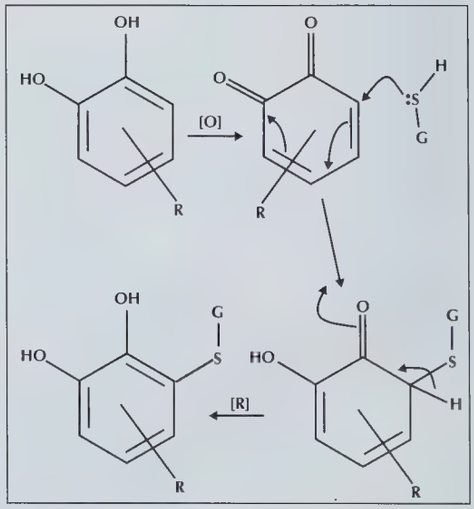

Figure 6: Schematic of the antioxidant behavior of GSH in the presence of oxidized phenolic compounds. Oxidation [O] of the phenolic compound generates a quinone, which the GSH nucleophile targets to form the "grape reaction product." Restoration of the aromatic structure occurs.

Table I: Comparison of products that supplement glutathione content of fermenting juice.

Concentration (%)	Product A	BIO AROM
cysteine	0.15	1.60
glutathione	1.00	1.50
homo-cysteine	0.05	0.40
GLU-CYS	1.00	1.00
NAC	0.20	0.80
Total aroma protective power	2.40%	5.30%

Excessive racking should be avoided, as this process always introduces some oxygen, which promotes oxidation and thus GSH depletion. Additionally, the capacity of yeast lees to absorb oxygen is well established and this limits glutathione oxidation. Paradoxically, older barrels appear to preserve GSH better than new barrels, because the oxygen level found in wine in older barrels is lower than those found in newer barrels, presumably as a result of lower porosity in the used wood. These two latter points are illustrated in Figure 7.[2]

Glutathione can be supplemented during fermentation through the addition of a product such as BIOAROM®, which is rich in the yeast-derived redox-active compounds glutathione, cysteine, and N-acetyl cysteine. Since yeast will simply assimilate GSH prior to 2/3 sugar depletion, supplementation should only be made in the last third of fermentation (see Figure 3).

There appears to be a threshold below which GSH supplementation is far less effective at preserving wine aroma. We estimate this to be approximately 20 ppm of GSH in-bottle. This can be seen clearly in the comparison of the aromatic profiles of wines made from the same juice (2006 Sauvignon Blanc, micro-vinification in duplicate) using Product A and BIOAROM as aroma preservatives. The total antioxidant contribution of Product A is lower (Table 1), and this is demonstrated by aroma preservation that is no better than the control wine (Figure 8).

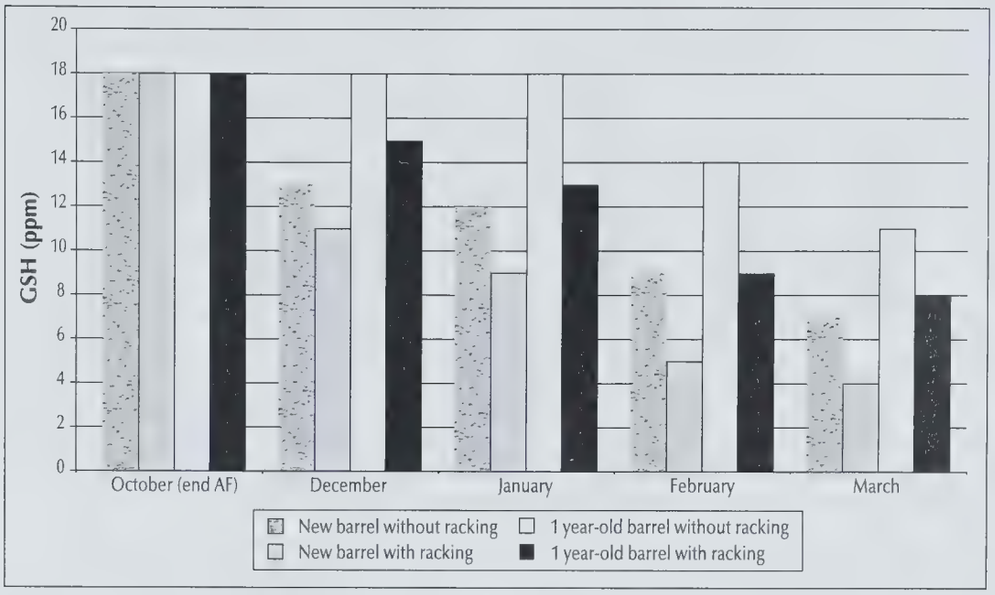

Figure 7: Comparison of glutathione content of wines handled in new and 1 year-old barrels, with and without racking.

It is important to understand that GSH supplementation does not enhance the yeast's ability to generate aromas, but rather protects what aromas the yeast does produce. This can be seen clearly in Figure 9, where a control wine (Sauvignon Blanc) is compared with one made using GSH supplementation (BIOAROM®) and another made using DYNASTART®, a rehydration nutrient that is known to increase yeast aroma production.[1,11,12]

The most varietal wine aroma profile was produced when DYNASTART® was used, presumably due to stimulation of yeast metabolism and enzymatic activity, and the varietal aroma intensity of this wine exceeded the control by some margin. The wine treated with GSH supplementation during fermentation shows better preservation of aromas over the control, particularly for 3MHA (passion fruit), which is very susceptible to oxidation.

Examination of GSH concentration in the wines shows that only the wine treated with BIOAROM® had GSH above the nominal 20 ppm threshold, meaning that this wine is likely to retain these aromas during ageing to a far greater extent than the control or DYNASTART®-treated wine.

Summary

Although glutathione has been known for many years, it is only

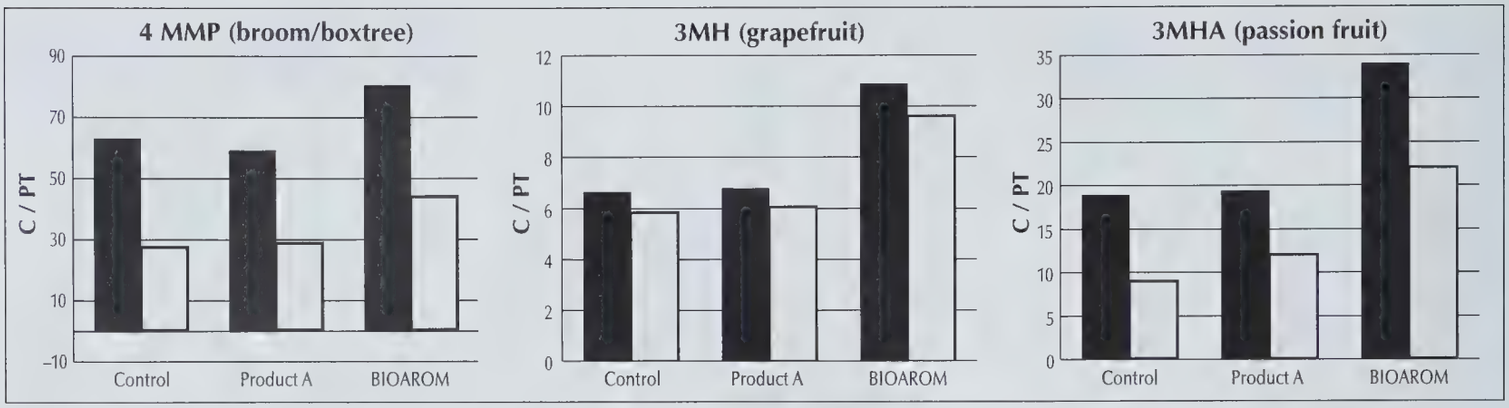

Figure 8: Comparison of two products aimed at wine aroma preservation: Product A and BIOAROM. Fermentation of Sauvignon Blanc juice in 2006, with microvinification in duplicate. Two time-points indicated are at bottling, and 3 months later with cellaring at 15°C. Concentration/ Perception Threshold (C/PT), where a value of ≥1 indicates contribution to wine aroma. 4MMP = 4-methoxymercaptopentanone (broom/boxtree); 3MH = 3-mercaptohexanol (grapefruit); 3MHA = 3-mercaptohexyl acetate (passion fruit).

recently that its importance with respect to wine aroma preservation during ageing has become recognized. Supplementation during fermentation is shown to be an effective method of increasing wine glutathione content to ensure that a sufficient amount is available in the final wine to provide adequate aroma protection.

While glutathione supplementation is important for all white and rosé wine, it is particularly relevant for wines that rely on strong aromas for consumer appeal, and also for those being exported where time is spent in transportation and storage under conditions that may not be ideal for aroma preservation. ■

Products discussed in this article are available in U.S. through LAFFORT USA,

724 Broadway St., Sonoma, CA 95476, tel 707/343-1632, laffortusa@laffort.com and www.laffort.com. Contact and technical support in the U.S.: Charlotte Gourraud, charlotte.gourraud@laffort.com.

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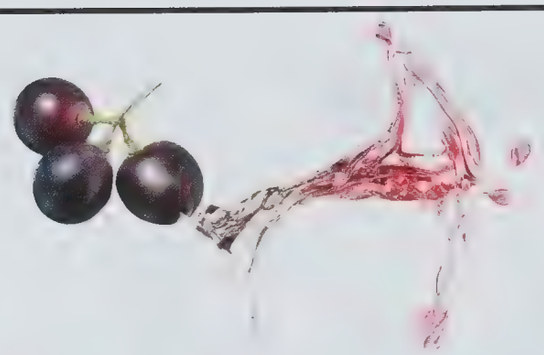

Lafase HE Grand Cru & Lafase Fruit
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Research[1] shows the impact of certain maceration enzymes on wine polysaccharide profile. Multiple studies already proved the significant contribution of certain enzymatic preparations to wine color stabilization, to astringency reduction and to the tartaric stability process.
This innovative study **demonstrates the influence of the enzymatic preparation on the polyphenol composition of red wines.**

[1]Results from Marie-Agnès Ducasse during her PhD at INRA Montpellier, in Veronique Cheynier team. Laffort & Novozymes financing.
Graph Translation: DPm (mean tannin polymerization degree), ACN (free anthocyanins), TA (tannin-anthocyanin), RGII (RhamnoGalacturonans II), PRAG (Proteins rich in Arabino Galactane), TPI (Total Polyphenol index = DO280), $PRSO_2$ (pigments resistant to discoloration with SO_2).

[2] Results of tasting at Faculty of œnologie Bordeaux, 2006, 19 Tasters.

The statistical analysis[2] shows that aromatic intensity, fruity character, roundness and structure are all significantly increased with enzyme treatment.

Lafase HE Grand Cru for age potential, structure and color stability

- Higher Tannin polymerization, and TPI: more tannic structure, more extracted material, richer wine and better age ability.
- RGII ↗ and PRAG ↘: RGII favor tannin aggregation whereas certain PRAG inhibit this, therefore an increase in RGII and a decrease in PRAG brings more stability and supple tannins.
- Higher Tannin-Anothocyanin complexes and $PRSO_2$: More anthocyanins bound in stable pigments (resistant to SO_2), which increases color stability for the longevity of the red wine.

Lafase Fruit for fruity wine, with color and roundness, and short maceration

- RGII ↗ and PRAG ↘: The increase in RGII will yield more tannin aggregation and supple tannins with less need for mechanical extraction. Gentle extraction will lead to less astringency in the wine.
- Fruity character and aromatic intensity ↗: Produce wines with intense fruit forward aromatics.

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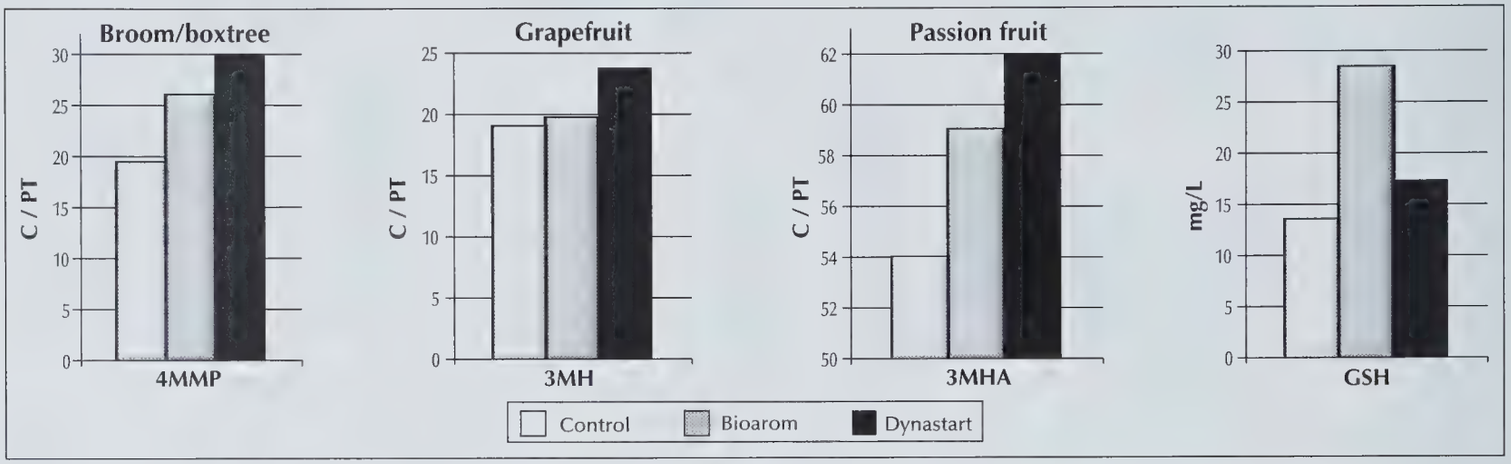

Figure 9: Comparison of increased production of varietal aromas in Sauvignon Blanc when the rehydration nutrient is used (Dynastart), compared with preservation of aromas generated through GSH supplementation (Bioarom) without a yeast rehydration nutrient. Chart at right illustrates the relative concentrations of GSH (mg/L) found in the three wines.

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Optimal cluster exposure

Continued from page 24

came from a block with unique irrigation requirements that you may not be able to repeat elsewhere in the vineyard.

Making choices that balance multiple goals is difficult and the subject of another discussion. You are your own best judge of how to balance your priorities. In establishing your targets, you have built an in-house growth and performance model. Congratulations!

Each year, you will decide if you have enough information to adjust your targets based on performance. Seasons vary. In some years, you may feel that atypical results should not influence your future targets. Good record keeping and numerical analysis can help you determine which years are really abnormal.

8. Optimize your sampling by checking for variability within blocks. Within each block, compare the metrics computed for each of three sentinel panels. If they are substantially different, you may have more variability within that block than you originally thought. In this case, you should further sub-divide that block for future analysis. Likewise, if you find that certain panels or blocks perform identically every year, you might want to combine them and reduce the number of sentinel panels measured each year.

Back to the future

Let us revisit a hypothetical hot summer afternoon. Imagine that you know exactly where your clusters are, and that they have been precisely positioned — guided by predictive light models that were defined in accordance to production and marketing goals, and by a precise understanding of your vineyard variability.

Imagine the possibilities that these models could hold, such as how much unexpected heat the fruit can handle before you need to intervene, or alerting your winemaking and marketing teams to consider the possibility of positioning the upcoming vintage around revised flavor and aroma profiles.

Stop imagining — and start building the quantitative understanding of your vineyard variability and product quality that will begin to define your models. Welcome to 21st century viticulture. ■

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J.Lohr Vineyards & Wines

WATER IS THE NEW ENERGY

BY Tina Vierra

Smart water management can lead to both cost savings and energy savings. Jeff Zucker, safety and environmental coordinator at J. Lohr Vineyards & Wines, has been working to ensure the 800,000-case Paso Robles, CA facility makes the most out of every gallon of water.

"'Water is the new energy crisis in California,' came from a presentation on water conservation by Pacific Gas & Electric Company (PG&E)," recalls Zucker. "It refers to the energy needed to move water around the state of California. At this presentation, I really came to understand the idea that water is money."

PG&E experts report that water-related activity consumes:

- 19% of California's electricity;
- 30% of its natural gas; and
- 88 billion gallons of diesel fuel annually.

J. Lohr's volute dehydrator (also known as a dewatering press), separates clean water (sent to a storage pond) from solids, producing sludge dry enough to be used in compost.

Such energy use also applies in the winery. It takes energy to pump water out of the ground, pressurize the system to move water around the winery, heat water, treat wastewater, and disperse treated water.

In 2003, Zucker and his team began planning a more comprehensive water conservation program, fully implemented by Harvest 2004 and ongoing, which has cut water usage by 30% — an average of one million gallons of water per year.

Measuring and planning water use

First, Zucker and his team purchased portable flow meters and took measurements. They designed a spreadsheet that used winery production activities to predict water use for tasks including rinsing more than 200 new barrels per day with hot water [1½ minutes] with Gamajet high pressure/low flow barrel washing sprinkler heads and tank cleaning. Zucker set up a comparison for how much water the winery should be using for an activity, with how much water they were actually using.

Facility expansion

Expansion of the Paso Robles facility began in 2006. The winery doubled the size of the blending room, adding over 700,000 gallons of tank capacity, and added another fermentation building. In the new building, the winery placed various tanks sized to suit winemaking needs (creating boutique winery projects within the larger production facility), with fermentation capacity reaching almost 1.3 million gallons by 2010.

Twenty-eight open-top fermentors (six with 6-ton capacity and 22 with 12-ton capacity), with pneumatic punch down devices and separate crush and press equipment, were added, to ensure gentle treatment of grapes.

Equipment to save water

Under Zucker's leadership, the winery has added new technology, including equalization tanks and a dewatering press.

Two types of high-pressure/low-flow nozzles were installed on all hoses in the winery. The new nozzles reduced the flow on each hose from 20 gallons per minute (gpm) to 7 gpm.

A generic, inexpensive (just under $3 each) two-inch sweeper nozzle screws onto quick-connect couplers, which are standard throughout the winery. The threads on the nozzles do not match the threads on the couplers (garden hose threads instead of national pipe threads), but the addition of an extra rubber washer in the nozzle fits well and prevents leaks.

A second, pistol-style nozzle from Strahman Valves is heavier in weight and more costly ($150 each), but cellar technicians at the winery like its usefulness. The

An "indexing" rotary impingement barrel washing nozzle and wand gives a 360° cleaning pattern and saves up to 80% of water and chemicals used in manual barrel cleaning.

Strahman pistol nozzles can change the spray pattern from fog to stream, handle hot water without transferring the heat to the user's hand, and are very durable. Cellar workers use these nozzles in the barrel rooms, where the ability to have a fog spray pattern is important. Zucker will purchase more of these nozzles, as cellar technicians prefer them.

The winery adopted new technology for barrel cleaning in 2004, using rotary impingement (force behind the jet stream) nozzles from Gamajet Cleaning Systems. The rotary impingement nozzles and wands are patented engineering designed to use the least amount of water with the ultimate amount of force. The barrels are washed with hot water, followed by a cold, ozone water rinse for sanitation.

The Gamajet E-Z7 barrel blaster used at J. Lohr also "indexes," offering a 360° cleaning pattern inside the barrel, resulting in clean barrels in as little as two minutes, and saving 80% of the water, chemicals, and energy needed to clean the barrels manually.

A Gamajet IV automated, fluid-driven rotary tank cleaner is used to clean large tanks (diameter over 15 feet) with similar water and energy savings. Manual cleaning or sprayballs (other common tank cleaning methods) typically use approximately 40 gpm and are often left running for hours before a tank is considered clean. The rotary tank cleaner can finish in less than an hour, cutting the water usage as much as 80%.

"For tank cleaning, a pre-determined amount of water is put into a hopper, then circulated into the tank through a tank cleaning sprinkler (we use both Cloud and GamaJet)," Zucker says, "and then the water drains back into the hopper, creating a loop."

Employee behavior and contributions

Turning his attention to employee training, Zucker established specific lengths of time, or recommended gallon amounts, for each activity involving water use, after consulting with the winemaker and plant manager to determine how much water is required to complete each task.

"Some things were based on time, like how long it takes to wash a barrel. The longer the valve is open on the barrel washing wand, the more water is used," Zucker explains. "The amount of water used to wash a tank is determined by tank size."

Water conservation was promoted to all employees as a priority. In 2004, Zucker conducted pre-harvest training sessions, explaining ideas and work changes to save water, and establish goals for water savings.

"That first year, we would raffle off a weekly prize if water use goals were met, such as a gift certificate to a store or restaurant, or we would offer lunch for everyone during harvest," Zucker recalls. "This way everyone became involved.

"A Water Usage Board that we mounted in the break room was very effective, with the total amount of water use entered daily. Encouraging messages posted on days that we were under goal provided a small bit of entertainment and encouraged people to pay attention to the board, and therefore the water usage numbers."

Placing a clock with a sweep second hand next to the barrel washing stations allowed employees to keep track of washing time. The cellar crews stopped the constant wash down of grape skins off of the floor.

As cellar crews became increasingly involved in the water savings efforts, they were encouraged to contribute ideas to further the program. The team came up with ways to effectively reuse water.

Recovery/reuse of wash water

Zucker plotted a strategic water reuse program and implemented it during the 2009 harvest.

Each morning they are scheduled to receive grapes, crews flush the must lines with hot water. The clean water left in these lines is pumped back into a hopper underneath the crusher/ destemmer instead of being flushed down the drain. Crews pump the saved water into two 275-gallon totes for later use.

Water in the totes is then used to start the must line cleaning process at the end of the day. Each day this reuse technique was applied, the winery recovered 450 to 500 gallons of water, which Zucker estimates to be about 25% to 30% of the water that was used to flush the lines in the morning.

"Sometimes being creative and looking at the big picture can net surprising results," notes Zucker. "After analyzing our sanitation procedures, which are very important to us, we discovered that by cleaning these must lines twice per day as opposed to the standard once per day, we actually save water. That seems counter-intuitive, since we are doubling water use for the actual line cleaning, but in the long run we actually save water by using more water for cleaning at this earlier stage of the winemaking process."

When employees wash a tank, if the tank was not too dirty to start with, the wash water will be used to wash another tank (with more cleaning chemical added), saving 50 to 150 gallons of wash water, depending on tank size. Another 50 to 150 gallons of water is saved in the rinse/sterilization cycle. The cellar supervisor has suggested acquiring more totes so crews can use the tank rinse/sterilization water to clean the concrete floors during harvest, getting yet another use from that water.

Wastewater system and treatment

J. Lohr's Paso Robles facility has an activated sludge with return system for treating wastewater. Bacteria in a bio-reactor (an 88,000-gallon cement pond with two aerators) break down sugars, alcohol, and other "food" that is produced in the winery waste stream, in a 100% aerobic process. Sanitary waste is handled separately in a septic tank system.

A rotary screen separates large solids, and the water flows to four tanks re-tasked for this use (total capacity of 40,000 gallons) before being fed to the bio-reactor.

"Adding the tanks to the original system gave us much better control on heavy days, to equalize the strength of the water. Batches as large as 800 gallons flowing directly into the bio-reactor would shock it and cause the dissolved oxygen to drop below acceptable levels, and the clarifier and dewatering systems could not keep up with the amount of sludge," Zucker says. "Now we can meter the water into the bio-reactor throughout the day (and night), equalize the strength of the water, and have storage capacity for holding water on large water-volume days."

As water is fed to the bio-reactor, an equal amount of water flows out and into the clarifier along with a chemical flocculant to clump up sludge. When the sludge load was judged too much for the system, a volute dehydrator (screw press) was added to dewater the sludge.

The volute dehydrator draws water directly from the bio-reactor. The flocculant is added, and then the effluent passes through the screw press, with the solids coming out the end. Solids are then conveyed directly into a roll-off bin.

Clean water (effluent) that is separated out by the dehydrator flows into the clarifier, then into the storage pond over a weir. Any solids that wind up in the effluent will sink to the bottom of the clarifier, and will be pumped back into the bio-reactor. The clarifier provides a secondary way to separate water and solids, and helps prevent any solids from winding up in the storage pond.

"The volute dehydrator screw press has a system of alternating floating and stationary rings," Zucker reports. "As the screw moves effluent through the rings, the shearing action of the floating rings moving next to the stationary rings separates the water from the solids. The volute dehydrator is energy- and chemical-efficient, and produces sludge that is dry enough to go directly into a bin for use in compost."

The capacity of the system is now 24,000 gallons per day, and the water in the storage pond is used for dust control on vineyard alleyways.

Results

"The results of the water savings efforts have been exceptional," reports Zucker. Using 2003 as a base year for comparison, J. Lohr's Paso Robles facility has brought water use down from 3.5 gallons of water per gallon of wine to 1.6, and by 2008, gallons of water/gallons of wine use was down 55% from the start of the program (see Table I).

Zucker notes that the savings in 2005 were abnormally large because it was a very large harvest (more than 10,000 tons), processed in a short period of time. 2007 and 2009, also years in which processing reached over 10,000 tons, saw similar low-water usage of 1.2 gallons of water per gallon of wine.

Ongoing efforts

"Every year is a new challenge," Zucker says. "We do not let ourselves take the water savings efforts for granted. We re-train the staff, old and new, every year, and continue to look for new ways to conserve and reuse water. Every gallon of water that we waste reduces our bottom line and is literally money down the drain.

"Happily, our winemakers are also deeply committed to our conservation efforts, just as we are always supportive of their goal of making the finest wines possible." ■

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Laffort USA distributes the whole range of Laffort products directly in the U.S., and has added Jillian Johnson Phoenix (a UC Davis-trained former winemaker of Bonny Doon Vineyards), to its expert staff.

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Quertanin Sweet and Quertanin Intense are new ellagic finishing tannins extracted from oak heartwood. Along with the well-known Quertanin and Tanin Plus, these Instant Dissolving Process (IDP) products enhance wine structure and aromatics during ageing. Quertanin Sweet develops the perception of sweetness while contributing coconut and vanilla notes to a wine. Quertanin Intense amplifies mouthfeel together with toasting characteristics (almonds, coffee).

Tanin VR Color, a fermentation catechin tannin, is dedicated to color stabilization. Proprietary Oxyprotect™ production prevents the tannin preparation from oxidation, and renders it highly reactive with anthocyanins.

Zymaflore FX10 and F15, VL3 and X5, Dynastart, Lafase HE Grand Cru, VR Supra, Gecoll Supra and Stabivin SP are other top Laffort products available.

For more information, contact:
Laffort USA, Inc.
tel: 707/343-1632
e-mail: charlotte.gourraud@laffort.com; laffortusa@laffort.com
website: www.laffort.com; www.laffort.com/usa

PLEASE SEE LAFFORT AD, PAGE 57

SCOTT LABORATORIES INC.

It has been argued that the presence of wild non-*Saccharomyces* yeasts at the beginning of fermentations (particularly *Torulaspora delbrueckii*) can add to wine complexity. Positive results, however, have been a question of luck. For commercial yeast producers the challenge has been to isolate premium quality *Torulaspora* cells, dry them, and then pair them with compatible *Saccharomyces cerevisiae* for use sequentially in winery fermentations. Lallemand has now done this.

In 2010, Scott will offer Lallemand's new Level^2 TD fermentation kit, which mimics wild fermentations without the inherent risks and unpredictability.

Scott Labs adds several more traditional yeast strains to its portfolio in 2010, including "Clos" (an isolate from the Priorat region of Spain), and "BRG" (a value-added strain from Burgundy).

Scott Labs will broaden its range of organic yeast nutrient products to include Fermaid O, GoFerm, and GoFerm Protect (formerly known as Fortiferm).

SCOTT LABORATORIES

Gelatins, caseinates, and other specialty fining agents distributed by Scott, come from the Institut Oenologique de Champagne (IOC, Epernay, France), established in 1890 and one of the most prestigious houses of its type. The IOC also has facilities in Chablis, Burgundy, the upper Rhône, Provence (including Châteauneuf-du-Pape), and Languedoc.

In 2009, Scott Labs opened a satellite location at 190 Foss Creek Circle, Suite G, in Healdsburg, CA.

For more information, please contact:
Scott Laboratories, Inc.
PO Box 4559, Petaluma, CA 94955
tel: 707/765-6666; fax: 707/765-6674
e-mail: info@scottlab.com
website: www.scottlab.com

PLEASE SEE SCOTT LABS AD, PAGE 40

VINTNERS SUPPLY COMPANY

Vintners Supply Company (VSC) offers a complete line of filtration equipment from Velo acciai® (Italy). Velo's new crossflow systems are available from 800 to 10,000 gallons per hour, and provide maximum filtration surface area in the smallest space possible.

Velo acciai®
STEEL PASSION

Velo systems utilize proprietary polypropylene membranes, each with 18 square meters of filtration area, available in 0.2- and 0.45-µ pore size. The systems are fully automated for 24-hour operation, with an automated backwash system to maintain high filtration flow rates. The system has four main phases: micro-filtration of wine, draining of wine with nitrogen pressure, washing system with water and cleaning agents, and final water rinse.

VSC offers a full line of filtration media and supplies, including cartridge filters, sheet filters, stacked disc modules, and filter aids. VSC is a leading supplier of replacement grape press membranes (made in Germany). Membranes are stocked at the VSC warehouse (Santa Rosa, CA) for immediate delivery.

For more information, contact:
Vintners Supply Company
Robert H. Moeckly
PO Box 153, St. Helena, CA 94574
tel: 800/366-6809; fax: 707/584-7955
website: www.vintnerssupply.com

PLEASE SEE VINTNERS SUPPLY CO. AD, PAGE 13

OAK SOLUTIONS GROUP

Oak Solutions Group is a premium oak products company providing expert advice, niche products, and unparalleled selection.

ēvOAK sets the standard for oak alternatives with innovations in design, toasting, and packaging of the finest French and American oak. ēvOAK products eliminate guesswork while offering the precise flavors winemakers are looking for:

ēvOAK Classic tank staves are created with an industry-leading monitoring system, ensuring repeatable, consistent flavors. **High Extract** staves are ideal for blending and deliver concentrated, singular flavor profiles to suit specific needs. **Latitude 44° Bordeaux, 45° Rhone,** and **46° Burgundy** staves apply a modern approach to long-term aging to give certain varieties finesse and elegance. French for *blend,* **Cuvée** staves are formulated for winemakers looking for flavor characteristics such as macaroon, coconut, and toasted marshmallow.

- ēvOAK oak chips and powder feature prime oak selection, seasoning, innovative toasting, and unmatched quality control.
- **ēno CUBES** are a combination of carefully-selected oak cubes (white and red fermentation blends, aging blends, and finishing blends) for each enological stage.

trū/tan gallo and ellagic-tannins, Oak Solution Group's newest introductions, are blends created using oak directly sourced from the same premium forest regions as fine French oak barrels, blended into three formulas: f^2 Fermentation Finishing, vf Vinification, and rf Reserve Formula.

Sample kits are available.

For more information, contact:
Oak Solutions Group
Paul Abbott, Oak Solutions Specialist
2557 Napa Valley Corp. Dr., Ste. D
Napa, CA 94558
tel: 707/259-4988; fax: 707/255-5952
e-mail: pabbott@oaksolutionsgroup.com
OR **Kyle Sullivan**, Oak Solutions Specialist
tel: 707/287-8555; fax: 707/255-5952
e-mail: ksullivan@oaksolutionsgroup.com
website: www.oaksolutionsgroup.com

VINQUIRY ENARTIS

Vinquiry offers Enartis fermentation and specialty winemaking products, along with labware and chemicals. Product highlights for 2010 include:

Vinquiry Collection of Yeast, consisting of traditional favorites from a proprietary collection of isolates started in 1980, featuring three popular yeast strains that winemakers have trusted for years. **VQ Assmanshausen** is the most popular yeast for Pinot Noir production. It has a long lag phase, is alcohol tolerant to 15%, enhances spicy characteristics, and contributes complexity and structural enhancement. **VQ 51** (formerly known as French Red), is the classic Bordeaux yeast for red wines. **VQ 10** is a white wine strain recommended for preserving varietal fruit character and contributing to mouthfeel in Chardonnay, Gewürztraminer, Pinot Gris, Riesling, Sauvignon Blanc, and Viognier. It also works well at low temperatures desired for white wine fermentations.

Enartis VINQUIRY

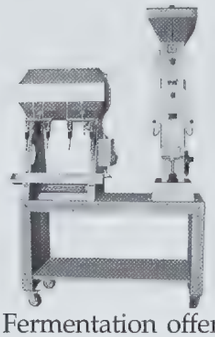
Vinquiry introduces its own **Wine Defects Kits**, ideal for staff training and identifying wine defects. Each kit includes common wine aroma defects related to cork taint, oxidation, *Brettanomyces*, malolactic fermentation problems, sulfur compounds, volatile acidity, and methoxypyrazines. Vinquiry Wine Defects Kits include 10 defect vials, each meant to spike 50ml of wine.

For more information, contact:
Vinquiry Enartis
Main Branch: 7795 Bell Rd.
Windsor, CA, 95492
tel: 707/838-6312; fax: 707/838-1765
e-mail: info@vinquiry.com
website: www.vinquiry.com
Napa Branch: 2025 Redwood Rd. Ste. 9
tel: 707/259-0740
Central Coast Branch:
2717 Aviation Way Ste. 100
Santa Maria, CA 93455
tel: 805/922-6321
Paso Robles Branch:
6305 Buena Vista Dr. Ste. 102
Paso Robles, CA 93446
tel: 805/591-3321

NAPA FERMENTATION SUPPLIES

New for 2010: Napa Fermentation Supplies will now be a distributor of Laffort yeast and winemaking products!

Napa Fermentation has an extensive array of winemaking supplies, including:
- Winemaking kits and ingredients;
- Wine yeast, nutrients, and malolactic cultures;
- Stoppers, bungs, spigots, wine hose, tubing;
- Labware, refractometers, and chemicals;
- Wine thieves;
- Oak products;
- Fermentation locks, buckets, and fermentors.



Napa Fermentation offers Lalvin fermentation supplies, including 23 strains of wine yeast and enzyme products. Malolactic bacteria include: Chr. Hansen Viniflora Oenos, Chr. Hansen CH 16, and Chr. Hansen CH35. Yeast nutrients include Fermaid K and Super Food.

Napa Fermentation has a full line of Zambelli winemaking equipment including crushers (up to 14 tons per hour), membrane presses, electric hydraulic presses, bladder presses, bottle fillers, auto corkers, pressure-sensitive labelers, plate filters, cooling units, pumps for light must, stainless steel fittings, and cam locks.

Napa Fermentation carries the Tivoli corking/filling machine (AISI-304 stainless steel), with four jaws for use with synthetic or natural corks with 22, 24, or 26mm diameter. Stainless steel fittings, and Karcher hot and cold pressure-washers are available.

For more information, contact:
Napa Fermentation Supplies
575 Third St., Bldg. A
(Inside the Napa Town & Country Fairgrounds)
PO Box 5839, Napa, CA 94581
tel: 707/255-6372; fax: 707/255-6462
e-mail: wineyes@aol.com
website: www.napafermentation.com

PLEASE SEE NAPA FERMENTATION AD, PAGE 44

GUSMER ENTERPRISES

Gusmer Enterprises, Inc. offers the latest breakthrough in primary fermentation nutrition; Micro*Essentials* Time-Release tablets. These nutrient tablets are formulated to dissolve slowly, and release nutritional components in a consistent manner over time. With time-release nutrients, the delivery profiles simulate incremental dosing by releasing components when most advantageous to the yeast.

***MicroEssentials* Time-Release tablets**

Fermentation nutrients have been available in powdered form for many years. While effective, powders can cause a breathing hazard, require multiple nutrient additions, and there can be loss at the tank during addition. Gusmer's Micro*Essentials* Time-Release formulation removes the need to make multiple additions, while providing a consistent level of nitrogen throughout fermentation.

Micro*Essentials* Time-Release tablets come in two forms: Complete-TR and Boost-TR. Complete-TR is a highly complex nutrient formulation that is ideal for most fermentations and Boost-TR is used as a substitute for DAP when the winemaker desires the ease-of-use and production benefits of time-release technology.

Gusmer offers a full range of:
- bacteria,
- yeast,
- nutrients,
- filter media,
- fining agents,
- enzymes,
- oak alternatives,
- lab supplies, and more.

Learn more at www.gusmerenterprises.com

For more information contact:
Gusmer Enterprises
81 M St., Fresno, CA 93721
tel: 559/485-2692; fax: 559/485-4254
e-mail: sales@gusmerenterprises.com
website: www.gusmerwine.com

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VINICAS, INC.

Vinicas is the only manufacturer/direct supplier of certified, high-quality, natural **(L+)Tartaric Acid** and **Cream of Tartar** in the U.S. With a new office/warehouse in Napa, and a Fresno location, Vinicas offers a line of quality cellar products and cleaning agents to wineries in California and throughout the U.S.

Vinicas offers distribution of the complete line of enological products from **Lamothe-Abiet**, (www.lamothe-abiet.com) focusing on the enhancement of each aspect of the winemaking process.

VINICAS

Based in Bordeaux, France, Lamothe-Abiet has been in the global enological business for 150 years, and brings this knowledge of winemaking to the new **NATUR'** product line. The 100% natural and allergen-free fining agents found in **Natur'Fine** and **Natur'Fine Prestige** enhance high-quality red, white, and rosé wines. They are a combination of specific yeast hulls with purified pectolytic enzyme that will release and drop out substances that cause turbidity. The quality of wine is improved by appearing clearer, cleaner, and more supple.

The **Natur'Soft** 100% natural preparation of specific yeast hulls is used in fermentation to increase phenolic compound stability, reduce tannin perception, and enhance fruitiness in red wine. **Polymix Natur'** is a specific non-casein formula for preventative or curative treatment of must and wine oxidation.

For more information, contact:
Vinicas, Inc.
194 Camino Oruga, Napa, CA 94558
or
2028 S. Third St., Fresno, CA 93702
tel: 888/204-9333
e-mail: info@vinicas.com
website: www.vinicas.com

PLEASE SEE VINICAS AD, PAGE 46

ATAGO U.S.A., INC.

After more than 70 years of designing and manufacturing accurate and reliable refractometers, ATAGO's name has grown to be an essential part of winemaking, and its products have set a standard for the industry. ATAGO digital hand-held refractometers uphold this standard.

ATAGO's digital hand-held "Pocket" PAL-1 ($295) has become the #1 recommended refractometer of winemakers around the world. It is the perfect upgrade for any vineyard or wine lab. The PAL-1 features a digital display that eliminates any variance from the user-interpreted readings of analog refractometers.

Ergonomically designed for one-handed operation, the PAL-1 quickly and accurately measures 0.0–53.0% Brix at the push of a button. The Automatic Temperature Compensation (ATC) element adjusts for any temperature discrepancies that may occur outside, and the body of the refractometer is water-resistant for quick and easy clean-up. The PAL-1 is lightweight and small enough to fit in a pocket, for use in the field. The MASTER-T analog refractometer, with ATC, is also available for only $175, with the same rigid ATAGO standards for quality and accuracy.

All of these convenient features have enticed winemakers to switch to the PAL-1. Quality refractometers by ATAGO offer ease of use and industry-renowned reliability.

For more information contact:
ATAGO U.S.A., Inc.
12011 NE First Street, Bldg. C, Ste. 110
Bellevue, WA 98005
tel: 877/ATAGO-USA; fax: 425/637-2110
e-mail: customerservice@atago-usa.com
website: www.atago.net/USA

STAVIN INCORPORATED

To replicate distinct profiles delivered by the world's finest cooperage, the StaVin research team has initiated a **barrel fingerprinting** project. Barrel fingerprinting integrates quantitative scientific analysis of barrel extractives, with qualitative sensory panels of leading winemakers. The application of analytical and sensory data to StaVin's traditional hand fire-toasting approach will enable StaVin to capture the essence of desired barrel profiles using StaVin products. StaVin selects oak with a winemaking approach rather than a marketing approach.

StaVin supplies French, American, and Hungarian oak products, including Savour oak, Tank Stave Fan Packs, StaVin Oak Beans and Stave Segments, the Barrel Replica, Traditional Barrel Insert, and Infusion Tube. StaVin recently introduced the "Barrel Head," a slightly heated oak product to blend with StaVin toasted products, adding richer mouthfeel and subtle nuances as tasted in only high-end barrels.

The paramount steps in StaVin's process to quality begin with careful quality control at every step, including three-year-plus seasoning of all oak staves, and finishing with meticulous hand fire-toasting programs.

For more information, contact:
StaVin Incorporated
Alan Sullivan, Steve Sullivan, Dr. Jeff McCord, Dr. Jeff Murrell, Jamie Zank
PO Box 1693, Sausalito, CA 94966
tel: 415/331-7849; fax: 415/331-0516
e-mail: info@stavin.com
website: www.stavin.com

PLEASE SEE STAVIN AD, PAGE 33

KOCH MEMBRANE SYSTEMS

Koch Membrane Systems' (KMS) WF-3 crossflow microfiltration system is specifically designed to treat a wide variety of wines in a single-step filtration, increasing yield and allowing a winery to achieve a high return on its investment in the equipment.

The WF-3 is developed specifically for small wineries. This complete system, designed to provide a single filtration step from fermentation to bottling, decreases the total cost of ownership with lower capital costs, reduced energy consumption and higher yield. The unique microporous hollow fiber membrane developed and manufactured by KMS does not require periodic back-flushing, eliminating the need for back-flushing equipment and reducing lost production time.

The system includes a feed pump, recirculation pump, integral cleaning tank, and VFD controls — mounted on a mobile, caster-supported, stainless steel frame that fits through a standard doorway. A nitrogen gas connection is supplied for system blow-down, back-pulsing, and integrity testing.

KMS systems are flexible, efficient, and gentle on wine due to minimal oxygen pickup and heating. Also available are the WF-6, which is either automatically or manually operated for flows up to 45 hl/hr, and the fully automated WF-12, requiring little or no operator attention with flows up to 68 hl/hr.

For more information contact:
Koch Membrane Systems, Inc.
850 Main St., Wilmington, MA 01887
tel: 888/677-5624; fax: 978/694-7020
e-mail: info@kochmembrane.com
website: www.kochmembrane.com

NADALIE USA

Nadalie USA has provided American, French, and Hungarian oak products since 1980, bringing French know-how and heritage to Napa Valley.

From the tree to the barrel — Nadalie USA's tradition is mastering the whole manufacturing process from tree selection to the final product. The company has stave mills in the U.S. and France for all American and French oak products. The wood is at the company mills for a minimum of two years.

Nadalie, USA provides world-recognized French oak barrels from Tonnellerie Nadalie in Bordeaux France and from Tonnellerie Marsannay, in Burgundy.

From the same rigorous oak tree selection as its barrels, Nadalie produces Oak Add Ins adjuncts. With over 20 years of experience in this range of products, Nadalie oak fire-toasts all Oak Add Ins, and offers high-quality adjuncts for winemaking needs. Nadalie offers fermentation (mixture) and aging products for barrels (cubes, dominoes, oak chains, barrel inserts) and for tanks (tank staves, wine woods). All are available in French or American Oak.

For more information, contact:
Nadalie, USA/Tonnellerie Francaise
1401 Tubbs Ln., Calistoga, CA 94515
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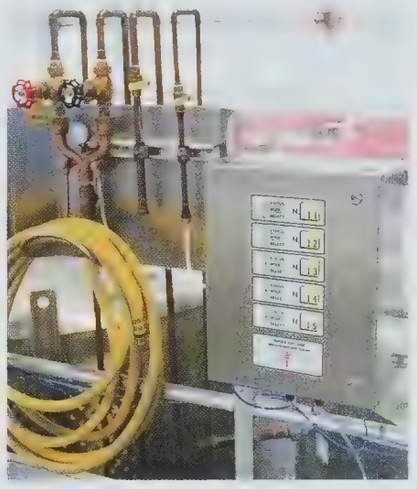
e-mail: info@nadalie.com
website: www.nadalie-usa.com

AMERICAN TARTARIC PRODUCTS, INC.

For years, winemakers have added oxygen to wine — it has only been in the last decade that specific tools for this task became available. Parsec has revolutionized micro-oxygenation technology by offering the only system that supplies oxygen by weight instead of volume.

When releasing a potentially dangerous gas like oxygen in a wine tank, you have to be absolutely sure that the quantity you release is precise, in order to be able to repeat it. There is a wide range of equipment that measures oxygen dose by volume (ml). A liter of gas can be a very small quantity (at low pressure and high temperature) or very large quantity (at high pressure and low temperature). To measure gas by liter, a winemaker must refer to a specific pressure and a specific temperature.



Usually, micro-oxygenation equipment is fed by a gas cylinder, and the pressure-reduction gears are not able to provide a precise pressure value. Parsec systems have taken this into account by measuring the weight of the oxygen molecule, temperature, and pressure to the micro-second with no calibrating, assuring the most accurate system available today. Systems are available from one to 120 units and are PC-compatible.

For more information, contact:
American Tartaric Products, Inc.
1230 Shiloh Rd., Windsor, CA 95492
tel: 707/836-6840; fax: 707/836-6843
e-mail: bill@americantartaric.com
website: www.americantartaric.com

PLEASE SEE AMERICAN TARTARIC AD, PAGE 38

LALLEMAND

Lallemand's expertise in wine fermentations has been successfully applied to the selection, characterization and production of natural yeast and bacteria. These yeast and bacteria selections respond to the needs of winemakers to control fermentations while promoting the expression of a particular style of wine, and respecting terroir.

New yeast offerings from Lallemand include:

Lalvin CLOS® winemaking yeast selected by the University of Rovira i Virgili in Spain from the Priorat region (province of Tarragona). Vinification trials show Lalvin CLOS has a very good implantation rate under conditions such as low nitrogen content over a wide range of temperatures. The results of experimental and winery trials with Carignane, Grenache, Shiraz, and Tempranillo grapes confirm Lalvin CLOS's potential as an excellent tool to enhance aromatic complexity, structure, and mouthfeel.

LEVEL 2 TD® is a compatible yeast couple (a non-*Saccharomyces* yeast and a *Saccharomyces cerevisiae* yeast) used in sequential inoculation, in order to promote aromatic intensity, complexity, and mouthfeel in white wines.

For more information, contact:
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Sigrid Gertsen-Briand: sigrid@lallemand.com,
Shirley Molinari: smolinari@lallemand.com
website: www.lallemandwine.us

PLEASE SEE LALLEMAND AD, PAGE 14

PRONEKTAR BY RADOUX USA

Pronektar is a complete line of oak alternative products from Tonnellerie Radoux, made from the same oaks that Radoux uses to make its fine oak wine barrels. All wood is aged and then convection-toasted to exacting specifications. Available in French and American oak, Pronektar's products are divided into two categories: oak used for fermentation, which includes powder and granulate; and oak used in aging, which includes chips, staves, segments, and stick sets. A Radoux sales representative is available to consult with winemakers about the benefits of each product.

Pronektar
THE FRUIT OF THE WOOD

NEW: Nektar Fresh are dried (not toasted) French oak granulates specifically made for use during fermentation of red and white wines. Nektar Fresh reduces vegetal characteristics, protects against oxidation, stabilizes color, provides volume and sweetness, reduces astringency, prepares wines for barrel aging, and decreases the risk of reduction in white wines.

Premium American oak staves are made from tight-grain premium barrel stave Minnesota oak, 24 months naturally air-dried, and a prolonged (20-hour) low-temperature convection toasting program for softer, integrated tannins, maximum vanilla and sweetness extraction. Dolce Vanilla is an exclusive recipe of the finest oaks and toasts, that contributes balanced vanilla and lactone flavors, volume, and sweetness.

For more information contact:
Radoux USA
Martin McCarthy
480 Aviation Blvd., Santa Rosa, CA 95403
tel: 707/284-2888; fax: 707/284-2894
e-mail: mmccarthy@radoux-usa.com
website: www.radouxcooperage.com

ST. PATRICK'S OF TEXAS

Winemaking supplies carried by St. Patrick's include:
- Valves and fittings;
- Membrane cartridge filters and filter housings;
- Filter sheets.

St. Patrick's of Texas

For more information and on-line ordering, please contact:
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1828 Fleischer Dr., Austin, TX 78728
tel: 512/989-9727; fax: 512/989-8982
e-mail: stpats@bga.com
website: www.stpats.com

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SMART VITICULTURE *by Dr. Richard Smart*

Vine breeders;

Past, Present, and Future

Have you thought about Mother Nature as a vine breeder? Since our grapevines are mostly clonal selections propagated from cuttings, we tend to forget that grapevines also grow from seeds. Consider Cabernet Sauvignon, made world famous in Bordeaux, after having been selected at some point "from the wild," like other well-known varieties of *Vitis vinifera*, the European wine grape.

DNA analysis proves Cabernet Sauvignon to be the "progeny" of a cross between **Cabernet** Franc and **Sauvignon** Blanc. The name Cabernet Sauvignon is truly a coincidence, reflecting part of each parent's name. Similar DNA studies prove that Chardonnay, and other French white varieties Melon and Aligote, and the red variety Gamay Noir, are all the progeny of parents' Pinot Noir and the little known Gouais Blanc.

Unfortunately, grape seeds do not all produce good wine grape varieties. Creating grapevine varieties is much like creating human babies. There is a father, in the vine's case providing pollen, and a mother, providing a stigmatic surface that allows pollen to germinate, and to fertilize the eggs, which eventually forms individual seeds in a berry. Each seed in a berry can create a "seedling" plant, but it is a new variety that shares traits of the mother and father vines. The other seeds in the berry are "siblings" with the same mother, but all are genetically distinct, as are human babies.

A big difference between cultivated grapevines and people is that a grapevine flower is "hermaphroditic," that is, it has both male and female parts. So we can have a seed in a Chardonnay berry with the same "mother" and "father," both being Chardonnay. Will this seed produce a vine that is Chardonnay? No! (To create Chardonnay, we need Pinot Noir and Gouais Blanc as parents, remember?)

New Chardonnay vines are propapagated vegetatively from a selected Chardonnay "mother" vine; this vine will have been selected and tested to possess desirable viticultural and winemaking attributes. This cloning process is not available to humans — yet.

With lots of pollen floating around vines in nature, we have millions of potential new varieties in seeds of grapes, but most do not germinate. This is the origin of our "traditional" varieties, which are selected by man from the wild, given names, and propagated by cuttings. For a limited number of these varieties, mainly French, they are planted and consumed around the world, and are known generically as "international varieties."

Enter human breeders

Man can intervene in this process by choosing the parents, one variety as the father (pollen source) and another as the mother, from whose berries the seeds will be taken. Normally the mother's flower is emasculated (anthers removed) to prevent self-fertilization, and pollen from another parent is provided.

A big burst of grapevine breeding took place in the late 1800s after phylloxera invaded Europe. Breeders strove to create vines with tolerance to phylloxera that also possessed European wine style. The resulting varieties are loosely called "French hybrids," and many were developed by private breeders. Since then, many academic institutions have become involved in grape breeding, mainly in Europe, especially Germany. In the U.S., Cornell (Geneva) in New York state, the University of Minnesota, and the University of California at Davis have grape breeding programs. However, this column is about a handful of private grape breeders in the U.S.

Coterie of American private grape breeders

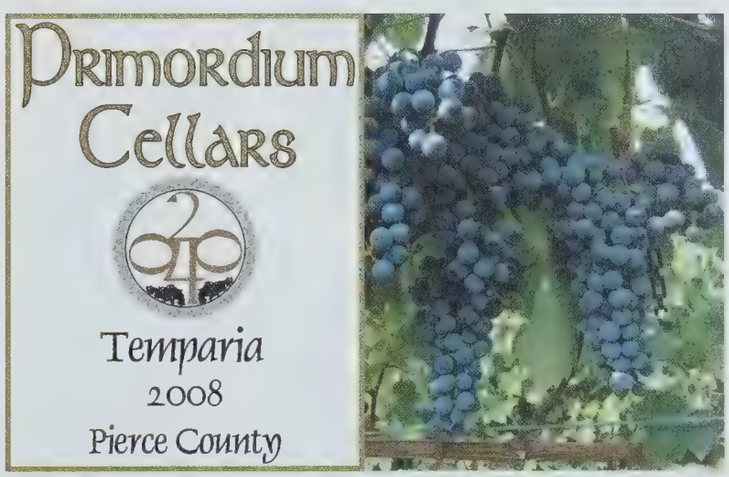
For this column, I interviewed a group of innovative grape breeders, Tom Plocher (Hugo, Minnesota); Mark Hart (Bayfield, Wisconsin); Ed Swanson (Cuthill Vineyards, Pierce, Nebraska); and Lucian Dressel (general manager of Illinois Cellars, Carrolton, Illinois), and asked them about their work.

How did they become involved in grape breeding?

Hart worked as a computer programer when he could not get work as a research biologist; he followed his family connections with fruit growing in his off hours. Now, his "day job" as a biologist with the U.S. National Park Service pays the bills and supports his "habit/hobby" as a private grape breeder. Swanson became involved with grapegrowing about 30 years ago, and began breeding new varieties to help Nebraska's first winery, Cuthills Vineyards.

Three of these men were inspired by meeting and working with important American grape breeders. Plocher works as a staff scientist at Honeywell and has a background in cognitive sciences and psychology. He caught the grape breeding "bug" from the great Elmer Swenson, legendary private breeder of Minnesota. Hart was also inspired by visits to the Swenson Vineyard.

Dressel, on the other hand, began a flirtation with viticulture when only 16 years old. Philip Wagner (pioneer of hybrid winemaking in the eastern U.S., grapegrower and founder of Boordy Vineyards, Hydes, Maryland), was his early mentor. While living in California, Dressel's neighbor was Harold Olmo (UC Davis grape breeder and Professor Emeritus), who taught him grape breeding in 2000.



The first Primordium Cellars Temparia was from the 2008 harvest.

Left: Crimson Cabernet bred by Lucian Dressel, a cross of Cabernet Sauvignon and Norton. The bunches resemble Norton. Right: White Norton bred by Dressel.

What are the aims of these breeding programs?

Private breeders have control of their breeding program aims. Dressel knows that **Norton** (the native American grapevine) makes the best wine of all of American species (it is likely Norton has a white vinifera as one parent). His ambition has been to combine Norton's tolerance to disease and phylloxera with the wine quality of European varieties.

Hart wants to produce varieties that are cold- and disease-tolerant but are also adapted to short, cool summers. His target regions are the northern Great Lakes states, through New England and southern Canada to the Maritime provinces.

Plocher and Swanson both have the common goal of improved wine quality. Plocher desires winter hardiness to –40°F, and in the wine, he looks for good tannin structure and aromatic complexity. Swanson's aim is driven by his wine customers — "to improve structural backbone and mid-palate tannins to compare with those we are used to in red vinifera wines."

What resources does a private breeder need?

The breeders I interviewed each have access to a few acres of land to support growing their parent vines and the seedlings. The local woods provide native vines adapted to the climate, especially the North American indigenous species *Vitis riparia* for Hart who hires a glasshouse to propagate seedlings.

All are able to do their seedling selection "au naturel." That is, they plant their seedlings outside, let the winter cold and diseases do their best to kill those not able to resist, and select for fruit and wine characters from the survivors. An ability to make small lots of wines every year is also necessary. Plocher says, "I can honestly say that I have rarely used

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a variety in breeding that I have not made or at least tasted wine from."

Hart gives an idea of the numbers of vines involved and the time it takes to breed new varieties. He says, "The breeding intensity has increased from 10 to 20 crosses per year in the 1990s to about 100 crosses in recent years. That effort produces about 6,000 seeds, which generate about 3,000 seedlings.

"More than half the seedlings can be eliminated in the first year, based on low vigor or poor disease resistance. Then the vines are planted out in high-density seedling vineyards, with 3,600 vines per acre. After the vines reach age seven, perhaps only 20 seedlings or so still remain in contention.

"In the last few years, I have been identifying two to four new selections each year that are candidates for off-site testing; most of those will eventually reveal fatal flaws that preclude release. I am waiting for three to four years of fruiting results from multiple testers in different regions before I move any selection to naming and release, which translates to a couple more years."

What are the favorite varieties they have created?

Hart's program is too new for releases, but the others all have success.

Left: Tom Plocher released Petite Pearl in 2009.
Right: Zinthiana bred by Dressel is a cross of Zinfandel and Norton.

Plocher released **Petite Pearl** in 2009, with very good cold hardiness to –30°F. The berries do not split and they are quite resistant to rots. Petite Pearl produces a wine with deep color, soft middle tannins, and a complex nose that evolves in the bottle. The flavor tends more toward herbs and spices rather than "in your face" fruit.

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Plocher's other favorite "child " is **Skandia**, the Norwegian spelling of a village near his home. He came across this very early ripening red variety in his seedling vineyard in 2002 and sent it to a Norwegian friend to evaluate. Skandia ripens well in Norway, so the name is appropriate!

I have always admired the thoughtfulness of names selected by Dressel. He has many varieties available, see www.davisvines.com. They include **Crimson Cabernet, Cabernet Diane, Zinthiana, Cabernet Doré, Aphrodite, White Norton,** and **White Cynfandel**, all being crosses with Norton. No problem here with attracting consumer interest, or with creating linkages to traditional varieties, when using such imaginative names.

Dressel has been selling patented Davis Viticultural Research (DVR) grapevines since 2005. There are 34 certified growers in 13 states: Arizona, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Missouri, New Mexico, Tennessee, and Virginia. All growers have at least one acre of vines, a total of 55 acres. The first 2009 commercial wines will be from Kentucky and Kansas.

Because of climate similarities, Dressel is convinced that there is a big future for these varieties also in Asia. He is already discussing exporting them to Japan, where high summer rainfall and disease pressure makes grapegrowing difficult.

"Our 2009 harvest had rain every second or third day and the berries were unaffected," reports Dressel. "We have only released our 'bullet proof' vines to date. In the last two years in Illinois we have had awful weather (great for testing vines). The reason we came to central Illinois was to test these vines under high disease pressure and weather conditions. I think they would do very well in places like China and Japan where we certainly approximated their wet harvest conditions.

"I bottled some DVRs in December, 2009 to send some samples to Japan," reports Dressel. "The 2009 whites are all very reminiscent of Sauvignon Blanc with lots of lychee, banana, and pineapple flavors. I bottled a Crimson Cab 75% and Cab Diane 25% blend (2008) and was very pleased. It had been in used oak for nine months and I sterile-filtered it and ran it though a regular bottling line.

"The reds all show some Norton character, but the Cabernet and the Norton have blended quite nicely and unless one knew they were crosses they would pass for wines from South Africa or some other not so well-known vinifera location."

Swanson made an early selection from original crosses of Riparia and Tempranillo, which he called **Temparia**. He has other exciting varieties yet to be released.

"We made 100% Temparia wine in 2006 under our Cuthills Vineyards brand labeled as Reserve Red from 8-year-old vines," reports Swanson. "In the 2006 Jefferson Cup competition, we received an 'American Example of Greatness' for this wine.

"In 2007, we started our 'Primordium Cellars' brand for wines made specifically from our new hybrids. Our 2007 Primordium Cellars Temparia won medals in three separate competitions. In 2008, we started making a red from a blend from our own hybrids called Lot #1 Field Blend. The parentage is very diverse in this blend and literally runs the gamut of popular vinifera."

What is the future of vine breeding?

Whether future grape breeding is private or institutional, with global warming, we need more varieties suited to hot climates to cope. I am aware of some efforts to breed varieties suited to hot climates in the past — Olmo's in California and Australian scientists Alan Antcliff and Peter Clingeleffer. But we need much more effort, and it should be internationally coordinated to share germplasm and other resources.

Countries with hot grapegrowing regions, who are most at risk from climate change and could benefit, are the U.S., Mexico, Chile, Argentina, Australia, South Africa, Portugal, Spain, France, Greece, and Italy, to name a few.

I have great admiration for private grape breeders, be they breeding for hot or cold climates. Let us hope that they will be recognized and encouraged in their efforts. ■

Dr. Richard Smart is rewriting and thoroughly revising *Sunlight into Wine*. He is happy to receive statements from growers and winemakers about their commercial success with various aspects of canopy management. Persons interested to contribute should contact Dr. Smart at vinedoc@bigpond.net.au.

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"We feel it is important to be completely transparent about the details of this barrel," Renaudin adds. "Fleur de Quintessence barrels have a very personalized story, which we believe winemakers will enjoy sharing."

Vincent Roué, master cooper, will personally oversee the crafting of this limited production barrel with decorative chestnut hoops. "Centuries ago, the Gaulois began making barrels using chestnut hoops to hold the barrel together," explains Roué. "We are using the same traditional roots of our craft, while also maximizing the latest techniques modern technology has to offer to optimize the legacy of the Gaulois."

Located just outside of Bordeaux in St. Emilion, Tonnellerie Quintessence crafts European-styled barrels with a commitment to consistency and customization.

Contact Tonnellerie Quintessence at 707/935-3452 for toasting options to place an order. ■

Vine balance

Continued from page 49

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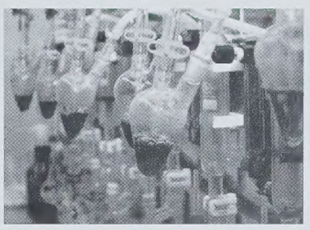

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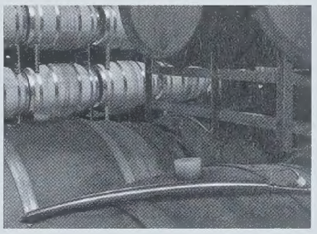

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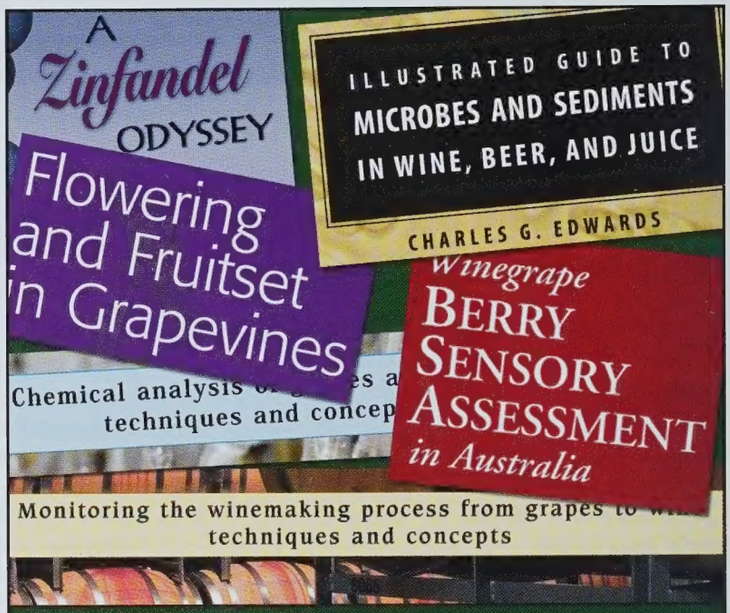
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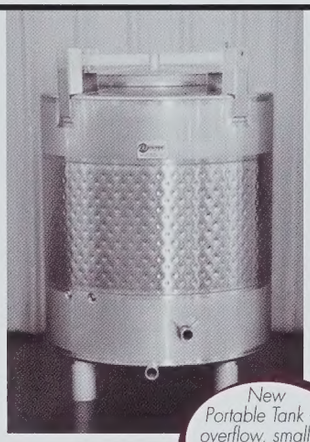

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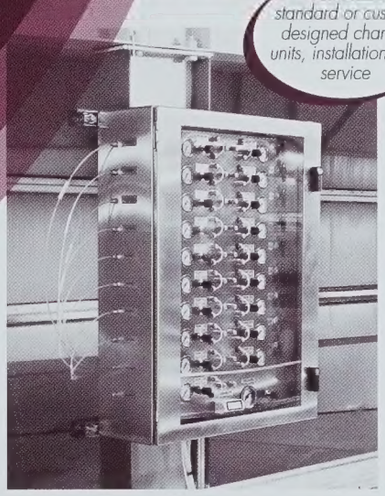

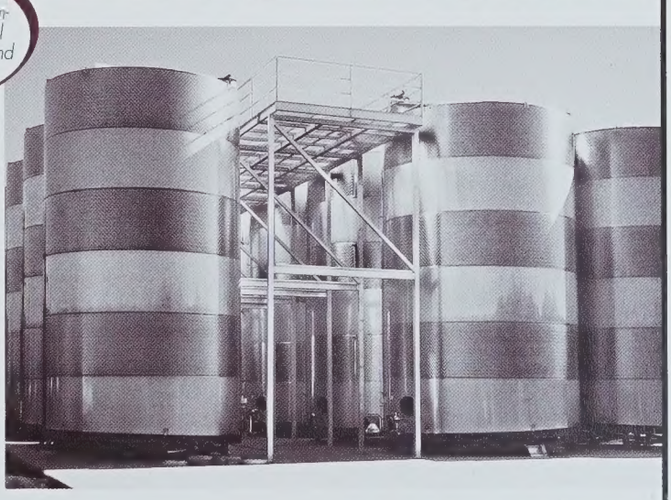

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